FE-Sizer Version 3.0

For Windows95/98/NT/2000/xp

Flow Meter Sizing

Control-Soft
Enterprises

User's Guide

CONTROL-SOFT ENTERPRISES

Control-Soft Enterprises
Instrument and Control Software for the Process Industries

FE-Sizer Version 3.0

For Windows95/98/NT/2000/xp

Flow Meter Sizing

© 1994-2010 Copyright Control-Soft Enterprises. All Rights Reserved
Licensed Material: Property of Control-Soft Enterprises
2319 Morning Park Drive, Katy, Texas 77494-2111, Phone (281) 217-6284 Fax (281) 395-5102

CONTROL-SOFT ENTERPRISES

Control-Soft Enterprises
Instrument and Control Software for the Process Industries

Information in this document is subject to change without notice and does not represent a commitment on the part of Control-Soft Enterprises. The software described in this document is furnished under a license agreement. It is unlawful to copy this software on magnetic tape, disk, or any other medium for any purposes other than the purchaser's personal use.

© 1994-2010 Control-Soft Enterprises. All Rights Reserved.

Third Party Copyrights: Integrated within FE-Sizer for Windows, Version 3.0 are the following products provided by third parties, who own the copyrights to these products. The products are trademarks or trade names of their respective owners:

Properties of Steam and Water using the 1967 IPC Formulation for Industrial Use and other IAPWS releases Copyright © 1993 by ASME. All rights reserved.

If you have comments about the software or this manual, please forward to Control-Soft Enterprises at:

Control-Soft Enterprises
2319 Morning Park Drive
Katy, Texas 77494-2111

TABLE OF CONTENTS

1. PROGRAM DESCRIPTION. 1
   - 1.1 Introduction. 1
   - 1.2 Meter Types. 2
   - 1.3 Sizing Methods. 2
   - 1.4 Factors. 2
   - 1.7 Units System. 2
   - 1.8 Record Keeping. 3
   - 1.9 Program Features. 3
   - 1.10 Version 3.0 Enhancements. 3

2. PROGRAM INSTALLATION. 5
   - 2.1 First Steps. 5
   - 2.2 The FE-Sizer Package. 5
   - 2.3 Necessary Equipment. 5
   - 2.4 Installing FE-Sizer. 5

3. DATA REQUIREMENTS. 7
   - 3.1 Symbols and Nomenclature. 7
   - 3.2 Fluid Data. 9
   - 3.3 Sizing Data. 10
   - 3.4 Meter/Pipe Data. 10
   - 3.5 Manometer Factor (F_M). 11
   - 3.6 Drain/Vent Hole Factor (F_{DH}). 11
   - 3.7 Water Vapor Correction Factor (F_{WV}). 11
   - 3.8 Saturated Liquid Factor (F_{SAT}). 11
   - 3.9 Vapor Quality Factor (F_X). 11

4. USER INTERFACE TYPES AND DESCRIPTIONS. 13
   - 4.1 Main Screen. 13
   - 4.2 Menu Bar. 13
     - 4.2.1 File. 14
     - 4.2.2 Edit. 14
     - 4.2.3 Tag. 14
     - 4.2.4 Fluid. 15
     - 4.2.5 Sizing. 15
     - 4.2.6 Factors. 15
     - 4.2.7 Meter/Pipe. 15
     - 4.2.8 Base. 15
     - 4.2.9 Utility. 15
     - 4.2.10 Window. 16
     - 4.2.11 View. 16
     - 4.2.12 Help. 16
   - 4.3 Pop-up Menus. 16
   - 4.4 Drop-Down List Boxes. 17
   - 4.5 Dialog Boxes. 17
   - 4.6 Text Boxes. 17
   - 4.7 Keyboard Shortcuts. 19
   - 4.8 Tool Bar. 20
   - 4.9 Status Bar. 21

5. FLOW METER SIZING. 23
- 5.1 Files. 23
  - 5.1.1 Project. 24
  - 5.1.2 Calculation. 27
  - 5.1.3 Datasheet. 27
  - 5.1.4 Print. 27
  - 5.1.5 Print Preview Pop-up Menu. 29
  - 5.1.6 Print Setup. 30
  - 5.1.7 Utilities Pop-up Menu. 30
  - 5.1.8 Most Recent Files. 31
  - 5.1.9 Exit. 31
- 5.2 Edit. 31
  - 5.2.1 Copy Tag... Ctrl+C. 31
  - 5.2.2 Paste Tag... Ctrl+V. 31
- 5.3 Tag. 31
  - 5.3.1 Input Tag Data. 31
  - 5.3.2 Retrieve Tag... Alt+R. 32
  - 5.3.3 Save Tag...Ctrl+Alt+S. 32
  - 5.3.4 Delete Tag... Alt+D. 32
- 5.4 Fluids. 32
  - 5.4.1 Input Fluid Data. 33
  - 5.4.2 Calc Fluid Properties. 33
  - 5.4.3 Gases & Vapors. 33
  - 5.4.5 Liquid-Volume. 34
- 5.5 Sizing. 35
  - 5.5.1 Input Sizing Data. 35
  - 5.5.2 Calculation Setup. 35
- 5.6 Factors. 36
  - 5.6.1 Manometer Factor (F_M). 36
  - 5.6.2 Drain/Vent Hole Factor (F_{DH}). 37
  - 5.6.3 Water Vapor Correction Factor (F_{WV}). 38
  - 5.6.4 Saturated Liquid Factor (F_{SAT}). 40
  - 5.6.5 Vapor Quality Factor (F_X). 40
- 5.7 Meter/Pipe. 41
  - 5.7.1 Meter Data. 41
  - 5.7.2 Pipe Data. 47
- 5.8 Base.... 48
- 5.9 Utility. 49
  - 5.9.1 Flow Units Setup. 49
  - 5.9.2 User Data. 49
  - 5.9.3 Uncertainty.... 50
- 5.10 Window. 51
- 5.11 View. 52
- 5.12 Help. 52

6. FE-Sizer TUTORIAL. 53
- 6.1 Setting Up the Project Database. 53
- 6.2 Calculating the Sizing Parameter. 56

7. DATA SHEET ENTRY. 61
7.1 Datasheet Entry - Part 1 of 3. 61
7.2 Datasheet Entry - Part 2 of 3. 62
7.3 Datasheet Entry - Part 3 of 3. 63

8. DATA IMPORTING AND EXPORTING. 65

9. FLUID PROPERTY CORRELATIONS. 85
9.1 Single Component & Multi-Component Fluid Selection Dialog. 85
9.2 Fluid Properties - Pressure and/or Temperature Data Dialog. 87
9.3 Equations-of-State. 87

APPENDIX A - WARNING MESSAGES. A-1
APPENDIX B - ERROR MESSAGES. B-1
APPENDIX C - PROGRAM EQUATIONS. C-1

1. PROGRAM DESCRIPTION

1.1 Introduction

FE-Sizer is a valuable engineering tool for sizing and selecting head-type flow meters in closed conduits. It is flexible, easy-to-use, and complete with appropriate menus and lists. The software includes meter selection, material tables and pipe data tables. A table of standard drain and vent hole diameters are available where the user selects the hole diameter to calculate the drain/vent hole correction factor, F_{DH}. These factors aid the user in selecting the proper meter application. Extensive built-in warnings flag potential application and data entry errors.

The program equations, methods and procedures comply with the following standards governing the sizing and specification of head-type orifice meter devices:

- ASME MFC-3M-1989 and ASME MFC-3M-2004 — *Measurements of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi*
- ASME MFC-14M-2003 — *Measurements of Fluid Flow Using Small Bore Precision Orifice Meters*
- ANSI/API 2530-AGA Report No. 3 (both 1985 and 1992 versions) — *Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids - Part 3 Natural Gas Applications*
- ISO-5167 (1991) — *Measurement of Fluid Flow by Means of Pressure Differential Devices — Part 1: Orifice Plates, Nozzles and Venturi Tubes Inserted in Circular Cross-section Conduits Running Full.*
- ISO-5167-2 (2003) — *Measurement of fluid flow by means of pressure differential devices — Part 2: Orifice plate*
- ISO-5167-3 (2003) — *Measurement of fluid flow by means of pressure differential devices — Part 3: Nozzles and Venturi nozzles.*
- ISO-5167-4 (2003) — *Measurement of fluid flow by means of pressure differential devices — Part 4: Venturi tubes*
- ISO/TR 15377 — *Measurements of Fluid Flow by Means of Pressure-Differential Devices - Guidelines for the Specification of Orifice Plates, Nozzles and Venturi Tubes Beyond the Scope of ISO 5167*

Sizing methods use the iterative procedure described in R. W. Miller's, *Flow Measurement Engineering Handbook*, Third Edition, McGraw-Hill Publishing Company. The discharge coefficient correlations include those above for their applicable flow devices. For all other meter types the discharge coefficient correlations are from the ASME standard and R. W. Miller's handbook.

1.2 Meter Types

FE-Sizer allows the user to select from the following orifice meter types:

- Orifice Plates: Concentric, segmental, eccentric, integral, honed small-bore pipe, quadrant, and conic style orifice plates.
- Flow Nozzles: ASME long radius, ASME throat tap, ISA nozzle, and Venturi nozzle with ISA inlet.
- Venturi tubes: Machined inlet, rough cast inlet, and rough sheet metal fabricated construction with either 7-degree or 15-degree outlet cones.
- Universal Venturi Tubes.
- Lo-Loss Tubes.
- Wedge Meters.

In addition, the user may enter custom calibrated discharge coefficients for calculating bores, flows, and differential pressures of custom or calibrated meter run applications.

1.3 Sizing Methods

FE-Sizer calculates the required orifice bore, flow, or differential pressure for the following fluid types:

- Ideal and non-ideal gases – volumetric flow.
- Vapors – mass flow.
- Viscous and non-viscous liquids – volumetric flow.
- Viscous and non-viscous liquids – mass flow.

Gas and vapor sizing equations may be either Pressure-Volume-Temperature (PVT) or Density form. Liquid flow sizing equations may be Specific Gravity or Density form. FE-Sizer includes "critical-drop" flow and bore formulas for sizing restrictive flow devices for gas, vapor and liquid fluids.

1.4 Factors

FE-Sizer includes special sizing factors important for flow meter corrections. Factors included in FE-Sizer are:

- Manometer correction.
- Drain and vent hole correction.
- Water vapor correction.
- Two phase flows – saturated liquid (0.0%-10.0% vapor mass to total mass content).
- Two phase flows – saturated vapor (90.00% -99.99% vapor mass to total mass content).

The factors correct the calculated bore, flow or differential pressure for specific applications.

1.7 Units System

FE-Sizer includes a completely selectable units system through pulldown selection lists that allows the user to change units "on the fly" for any calculated or input variable.

1.8 Record Keeping

FE-Sizer allows user to print calculation sheets, data sheets, calibration charts, or meter system uncertainty calculations from an easy-to-use menu system. FE-Sizer saves data records in a retrievable electronic format so future updates to the orifice sizing calculations and data sheets can be made simply and easily. Data records are retrieved using a built-in tag/data listing of the stored information.

1.9 Program Features

- Project database and management utilities for segregation of calculations by projects.
- Batch print of calculations, data sheets, calibration charts and uncertainty charts for projects.
- ASCII comma separated value (CSV) project file import and export to interface FE-Sizer with existing project databases.
- Batch calculation mode for automatic sizing of flow elements from fluid data imported from an external database.
- ASME steam and water property data correlations using the equations defined by 1967 IPC Formulation for Industrial Use.
- Built-in fluid properties database which includes fluid property correlations for liquid and gases for over 300 fluids.
- Flow meter index printout from within a project database.

1.10 Version 3.0 Enhancements

The FE-Sizer Flow Meter Sizing software package has many new features that improve the performance of FE-Sizer. Some of the features include:

- True 32-bit Windows operating system application.
- Support for long filenames.
- Selectable fonts and margins for hardcopy output.
- Detection of cavitation and flashing conditions for liquid flow meter and pressure restriction sizing.
- User definable margins for metric paper support.
- Easier and more flexible units system allows user to set units for individual calculations instead of an entire project file.

2. PROGRAM INSTALLATION

2.1 First Steps

Before you begin working with FE-Sizer:

1) Read your software license agreement.
2) Check the contents of your package.
3) Make sure you have the necessary equipment to run the program.

2.2 The FE-Sizer Package

Your FE-Sizer package includes the following:

1) This User's Guide.
2) 5-1/4 inch CD-Rom program disk.
3) The Control-Soft license agreement.
4) The Control-Soft software registration card.

Insure that you have everything listed above. Advise Control-Soft immediately if anything is missing.

2.3 Necessary Equipment

FE-Sizer requires the following minimum configuration to run properly:

1) An IBM® Personal Computer or true compatible.
2) Microsoft Windows®95, Windows®98, Windows®NT, Windows®2000, Windows®XP, Windows®2003 Server, or Windows Vista 32-bit (will also work with Windows Vista 64-bit in X86 compatibility mode).
3) One CD-Rom drive.
4) IBM® or compatible VGA or SVGA monitor.

2.4 Installing FE-Sizer

To get FE-Sizer up and running on your PC, follow the following steps. For example, assuming your CD-Rom drive designation is drive D,

1. Insert the FE-Sizer setup disk into drive D. The setup program should start automatically. Follow the onscreen instructions to complete the installation.

2. If the setup utility does not start automatically after inserting into the CD-Rom drive you may have Auto-Run disabled on your machine. If so, activate the Windows start bar, choose the Run command.

3. Type *d:setup.exe* and press enter (or use the browse button to select the *setup.exe* file by double-clicking on it). Follow the onscreen instructions to complete the installation.

The install program does the following:

- Creates one or more directories on your hard disk and copies the contents of the FE-Sizer program disk onto them.

- Creates a Windows application group and installs all FE-Sizer file icons there.

3. DATA REQUIREMENTS

3.1 Symbols and Nomenclature

Symbol	Description
C	Discharge coefficient, true flow rate divided by the theoretical flow rate.
C_∞	Discharge coefficient at an infinite Reynolds number.
d(ref)	Bore of head-type flow meter measured at 68°F (20°C).
d_{DH}	Diameter of a drain or vent hole.
dP	Differential pressure across the meter.
dP_m	Differential pressure across the meter measured at maximum flow.
dP_n	Differential pressure across the meter measured at normal flow.
D(ref)	Internal pipe diameter measured at 68°F (20°C).
D_b	Density at base conditions: Liquids, 60°F (15.6°C) and 14.7 psia (101.3 kPa); Gases, 60°F (15.6°C) and 14.69595 psia (101.325 kPa), or other base values.
D_c	Diameter of circle containing the segment of a segmental orifice.
D_f	Density of a liquid at flowing temperature.
D_{f1}	Density of a gas or vapor at upstream-tap flowing conditions.
D_{f2}	Density of a gas or vapor at downstream-tap flowing conditions.
D_F	Density of liquid at flowing conditions, uncorrected for pressure.
D_{GAS}	Density of gas or vapor portion of a two-phase liquid/vapor fluid.
D_{LIQUID}	Density of liquid portion of a two-phase vapor/liquid fluid.
D_M	Manometer-fluid density.
D_{TP}	Effective or homogeneous density of a two-phase fluid.
E	Velocity-of-approach factor for Buckingham Flow Coefficient Correlation.
F_{aD}	Thermal expansion factor for the pipe.
F_{ad}	Thermal expansion factor for the flow meter.
F_{DH}	Drain (gases or vapors) or vent (liquids) hole correction factor.
F_L	Local gravity correction factor.
F_m	Manometer correction factor.
F_p	Correction for liquid compressibility, D_f / D_F (usually 1.0 except at very high pressures).
F_{SAT}	Correction for saturated liquid (two-phase flow) conditions.
F_{TP}	Factor correcting static pressure to total pressure for critical drop sizing of gases and vapors.
$F_{WV,dry}$	Correction for wet-gas volume or mass to dry-gas volume or mass.
F_X	Wet-steam or wet-vapor quality correction factor.
G_b	Liquid base specific gravity with respect to water at 60°F.
G_f	Liquid flowing specific gravity at flowing temperature.
G_g	Gas or Vapor specific gravity ($M_{w\ gas} / M_{w\ air}$).
H_S	Segmental orifice plate height.
k	Ideal gas isentropic exponent or specific heat ratio (Cp/Cv).
K	Flow coefficient, $K = C / [\ 1 - \ ^4\ ]^{½}$.
K_0	Flow coefficient including velocity of approach at a hypothetical Reynolds number of infinity.
M_W	Molecular weight.
P_{atm}	Annual average barometric (atmospheric) pressure for a given geographic location.
P_b	Base absolute pressure for gas volume flows.
P_{f1}	Absolute static pressure at upstream-tap flowing conditions.

P_{f2}	Absolute static pressure at downstream-tap flowing conditions.
P_{WV}	Absolute pressure of water vapor in gas-water vapor mixture.
P_v	Vapor pressure of liquid at flowing temperature.
q	Gas or liquid volumetric flow rate at actual (flowing) conditions.
q_m	Gas or liquid maximum volumetric flow rate at actual (flowing) conditions.
q_n	Gas or liquid normal volumetric flow rate at actual (flowing) conditions.
Q	Gas or liquid volumetric flow rate at base conditions.
Q_m	Gas or liquid maximum volumetric flow rate at base conditions.
Q_n	Gas or liquid normal volumetric flow rate at base conditions.
R_d	Reynolds number of the meter bore.
R_D	Reynolds number of the pipe.
T_b	Base absolute temperature for gas volume flows.
T_{f1}	Temperature of gas, vapor or liquid at upstream-tap flowing conditions.
T_{f2}	Temperature of gas, vapor or liquid at downstream-tap flowing conditions.
T_F	Temperature at flowing conditions in degrees Fahrenheit.
U	Absolute viscosity of gas, vapor or liquid.
x	Quality or mass percent of vapor mass portion to total mass portion of a two-phase fluid.
X_1	Pressure ratio at the upstream tap pressure of the orifice, dP/P_{f1}.
X_2	Pressure ratio at the downstream tap pressure of the orifice, dP/P_{f2}.
W	Vapor or liquid mass flow rate.
W_m	Vapor or liquid maximum mass flow rate.
W_n	Vapor or liquid normal mass flow rate.
Y	Gas expansion factor.
Y_{CR}	Critical flow function for critical drop sizing of vapors.
Y_1	Gas expansion factor at the upstream tap pressure of the orifice.
Y_2	Gas expansion factor at the downstream tap pressure of the orifice.
Z_b	Gas or vapor compressibility factor at base temperature and pressure.
Z_{f1}	Gas or vapor compressibility factor at upstream-tap flowing conditions.
Z_{f2}	Gas or vapor compressibility factor at downstream-tap flowing conditions.
α_P	Thermal-expansion coefficient for pipe material.
α_{PE}	Thermal-expansion coefficient for primary-element material.
β	Beta ratio, d/D.
β_C	Segment beta ratio for a segmental orifice, β / 0.98.

SUBSCRIPTS:

1	upstream-tap condition.	2	downstream-tap condition.
b	base condition.	f	flowing condition.
m	maximum condition.	n	normal condition.

3.2 Fluid Data

Table 3-1 shows the required fluid data for each fluid type. FE-Sizer requires an input for all required data before sizing the flow meter for the given application.

Table 3-1

FLUID DATA		
Fluid Unit Equation	**Condition**	**Required Data**
Gas Volume PVT	Base	M_W or G_g, Z_b, Z_{f1} or Z_{f2}, P_{f1} or P_{f2}, T_{f1} or T_{f2}, U, k
	Flowing	M_W or G_g, Z_{f1} or Z_{f2}, P_{f1} or P_{f2}, T_{f1} or T_{f2}, U, k
Gas Volume Density	Base	D_b, D_{f1} or D_{f2}, P_{f1} or P_{f2}, T_{f1} or T_{f2}, U, k
	Flowing	D_{f1} or D_{f2}, P_{f1} or P_{f2}, T_{f1} or T_{f2}, U, k
Vapor Mass PVT	Flowing	M_W, Z_{f1} or Z_{f2}, P_{f1} or P_{f2}, T_{f1} or T_{f2}, U, k
Vapor Mass Density	Flowing	D_{f1} or D_{f2}, P_{f1} or P_{f2}, T_{f1} or T_{f2}, U, k
Liquid Volume SG	Base	G_b, G_f, P_{f1} or P_{f2}, T_{f1} or T_{f2}, U, F_p
	Flowing	G_f, P_{f1} or P_{f2}, T_{f1} or T_{f2}, U, F_p
Liquid Volume Density	Base	D_b, D_f, P_{f1} or P_{f2}, T_{f1} or T_{f2}, U, F_p
	Flowing	D_f, P_{f1} or P_{f2}, T_{f1} or T_{f2}, U, F_p
Liquid Mass SG	Flowing	G_f, P_{f1} or P_{f2}, T_{f1} or T_{f2}, U, F_p
Liquid Mass Density	Flowing	D_f, P_{f1} or P_{f2}, T_{f1} or T_{f2}, U, F_p

Notes: PVT - Pressure-Volume-Temperature Ideal-Gas Equation.

SG - Specific Gravity Liquid Equation.

Data can be at either upstream-tap condition (1) or downstream-tap condition (2). You cannot mix conditions in a calculation.

3.3 Sizing Data

Table 3-2 gives the sizing data for each fluid type. All required data must be entered before you can calculate the sizing parameter.

Table 3-2

SIZING DATA			
Fluid	**Condition**	**Sizing Parameter**	**Required Data**
Gas	Base	d & dP_n	Q_m, Q_n, dP_m
		Q_m & Q_n	dP_m, dP_n, d
		dP_m & dP_n	Q_m, Q_n, d
	Flowing	d & dP_n	q_m, q_n, dP_m
		q_m & q_n	dP_m, dP_n, d
		dP_m & dP_n	q_m, q_n, d
Vapor	Flowing	d & dP_n	W_m, W_n, dP_m
		W_m & W_n	dP_m, dP_n, d
		dP_m & dP_n	W_m, W_n, d
Liquid	Base	d & dP_n	Q_m, Q_n, dP_m
		Q_m & Q_n	dP_m, dP_n, d
		dP_m & dP_n	Q_m, Q_n, d
	Flowing	d & dP_n	q_m, q_n, dP_m
		q_m & q_n	dP_m, dP_n, d
		dP_m & dP_n	q_m, q_n, d
	Mass	d & dP_n	W_m, W_n, dP_m
		W_m & W_n	dP_m, dP_n, d
		dP_m & dP_n	W_m, W_n, d

Notes: To calculate sizing parameter for a single condition, i.e., maximum condition = normal condition, set values for data for the maximum condition equal to the data for the normal condition.

3.4 Meter/Pipe Data

- Meter type, e.g., orifice, venturi, nozzle, etc.
- Meter style, e.g., concentric, segmental, etc.
- Tap style, e.g., flange taps, pipe taps, etc.
- Meter material.
- Nominal pipe diameter.
- Pipe schedule.
- Pipe inner diameter.
- Pipe material.

3.5 Manometer Factor (F_M)

- Temperature of seal fluid at meter.
- Density of seal fluid at meter.
- Local acceleration of gravity.

3.6 Drain/Vent Hole Factor (F_{DH})

- Diameter of drain or vent hole (d_{DH}).

3.7 Water Vapor Correction Factor (F_{WV})

- Water vapor pressure at the flowing temperature.

3.8 Saturated Liquid Factor (F_{SAT})

- Density of gas or vapor portion (D_{GAS}).
- Quality or mass percent of vapor portion to total portion (x: $0.0\% \leq x \leq 10.0\%$).

3.9 Vapor Quality Factor (F_X)

- Density of liquid portion (D_{LIQUID}).
- Quality or mass percent of vapor portion to total portion (x: $50.0\% \leq x \leq 99.99\%$).

4. USER INTERFACE TYPES AND DESCRIPTIONS

4.1 Main Screen

The **Flow Meter Sizing** screen or *sizing screen* shown in Figure 4-1 displays all pertinent data required to size flow orifices for a given fluid type. FE-Sizer divides this screen into six sections with the following subtitles:

- Fluid Data.
- Sizing Data.
- Factors.
- Meter/Pipe Data.
- Base Conditions.
- Calculated Results.

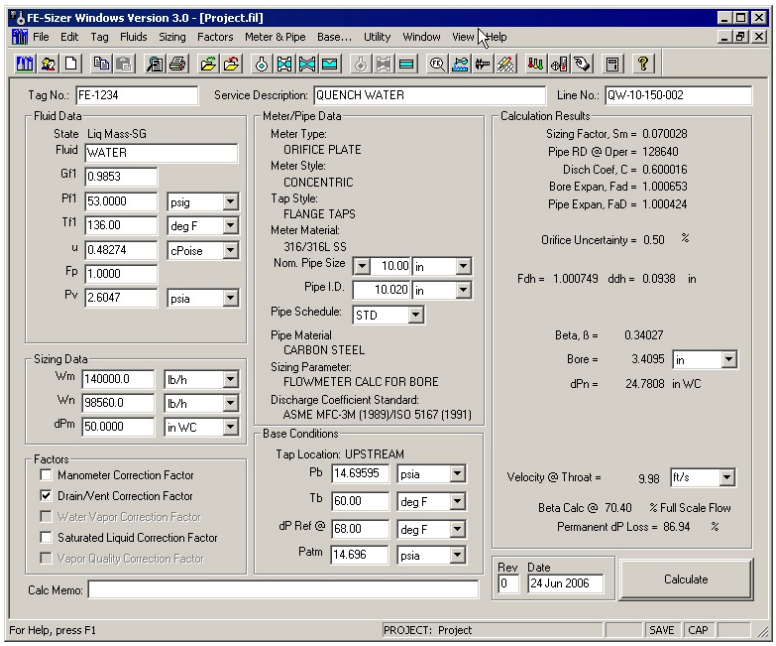


Figure 4-1

These sections organize all data into discrete segments to facilitate viewing all the data required to size a flow meter. The single screen format eliminates paging through multiple screens to check fluid data and meter information.

4.2 Menu Bar

At the top of the main screen illustrated in Figure 4-1 is a *menu bar* that lists the names (titles) of the available menus within FE-Sizer. The menu bar arranges the menu titles by category or specific function. The brief description for each title category and the respective pull-down menu items are:

- ❑ **File** - basic file and print commands for creating, opening, printing and closing project databases as well as various database maintenance utilities.
- ❑ **Edit** - for copying and pasting tag data with a project database or between project databases.
- ❑ **Tag** - for accessing individual tag records within a project database.
- ❑ **Fluids** - for setup of fluids and entering fluid data either manually or via property correlations.
- ❑ **Sizing** - for setup of sizing calculations and entering sizing data.
- ❑ **Factor** - menu of available correction factors.
- ❑ **Meter/Pipe** - for selecting among various meter styles and setup dialog for pipe data.
- ❑ **Base...** - activates dialog to set base condition data, i.e., base temperature and pressure, atmospheric pressure, etc.

- **Utility** - access various utility functions, i.e., flow units setup, user data - company and customer, or uncertainty calculation settings.
- **Window** - access various views available for FE-Sizer, i.e., arrange windows, icons, etc.
- **View** - used to display/hide the toolbar and status bar.
- **Help** - access the context sensitive on-line help, display FE-Sizer About dialog for program information..

Detailed descriptions of each menu item are given in the following sections.

4.2.1 File

- **Project** - pop-up menu where you select to create (new), open, close, save or delete project databases or select to import/export ASCII delimited data from an opened project database.
- **Calculation** - pop-up menu where you select to perform a batch calculation on an opened project or to clear all data for the current tag record.
- **Datasheet** - pop-up menu to enter data sheet data or clear data sheet data for the current tag record.
- **Print** - pop-up menu for printing calculation sheets, data sheets, uncertainty calculations, calibration charts or to batch print calculation sheets, data sheets, or tag indices.
- **Print Preview** - pop-up menu for previewing calculation sheets, data sheets, uncertainty calculations, calibration charts or to batch print calculation sheets, data sheets, or tag indices prior to printing to a printer.
- **Print Setup...** - activates the printer setup dialog box for setting various printer parameters.
- **Set Printer Font** - activates the font selection dialog box for selecting the print font for the program output.
- **Page Setup** - dialog box for setting the page margins - left and right, top and bottom - and the line spacing for printing calculations, data sheets, etc.
- **Utilities** - pop-up menu for maintaining project databases, i.e., packing and re-indexing a project database.
- **Most Recent Files List** - dynamic menu area that lists the most recent project files accessed.
- **Exit** - Exits FE-Sizer.

4.2.2 Edit

- **Copy** - copies the current project tag record to memory for pasting between projects.
- **Paste** - pastes the current tag record from memory into the selected project.

4.2.3 Tag

- **Input Tag Data** - sets input focus to the first item for tag number in the tag data area underneath the tool bar.
- **Retrieve Tag...** - retrieves a tag record from a project database - grayed or disabled until a project database is opened.
- **Save Tag...** - save a tag record to a project database - grayed or disabled until a project database is opened.
- **Delete Tag...** - deletes a tag record from a project database - grayed or disabled until a project database is opened.
- **Save Tag to File...** - saves tag data as individual tag file - grayed or disabled until a valid tag calculation file exists and sizing parameter calculated.
- **Retrieve Tag from File...** - retrieves tag data from an individual tag file.

4.2.4 Fluid

- **Input Fluid Data** - sets input focus to the first item of the **Fluid Data** section of the main screen.
- **Calculate Fluid Properties...** - pop-up menu for selecting the fluid correlation used to estimate the fluid properties.
- **Gases & Vapors** - dialog to setup sizing equation for gas and flows.
- **Liquids** - dialog to setup sizing equation for liquids.

4.2.5 Sizing

- **Input Sizing Data** - sets input focus to first item of the **Sizing Data** section of the main screen.
- **Calculation Setup...** - dialog to select the sizing parameter and calculation modes.
- **Calculate Sizing Parameter** - command to calculate sizing parameter based on user supplied input data.

4.2.6 Factors

- **Manometer...** - dialog for setup of factor for correcting the indicated differential for the effects of a gas or liquid leg of fluid at static pressure and temperature at the instrument for mercury U-tube manometers and mercury-manometer-type differential pressure instruments.
- **Drain/Vent Hole...** - dialog for setup of factor adjusting the calculation for the increased flow through a drain or vent hole.
- **Water-Vapor Correction...** - dialog for setup of factor converting a given volume of gas flow to a condition of moisture content other than that corresponding to flowing conditions - enabled only for gases and vapors; grayed or disabled for any other fluid.
- **Saturated Liquid...** - dialog for setup of factor correcting calculation for saturated liquid flows where the vapor quality (percentage of vapor mass to total fluid mass) is 10 percent or less - enabled for all liquids; grayed or disabled for all gases and vapor fluids.
- **Quality...** - dialog for setup of factor correcting calculation for saturated vapor flows where the vapor quality is 90 percent or more - enabled vapor mass flow fluids; grayed or disabled for all other fluids.

4.2.7 Meter/Pipe

- **Meter Type** - pop-up menu for selecting meter type, e.g., orifice, flow nozzle, venturi, etc.
- **Pipe Data...** - dialog for setup of pipe data, i.e., inner diameter, schedule, etc.

4.2.8 Base...

Activates dialog to set base condition data, i.e., base temperature and pressure, atmospheric pressure, etc.

4.2.9 Utility

- **Flow Units Setup** - dialog for setting and defining various flow units.
- **User** - pop-up menu where you can select to enter user, company and customer data.
- **Uncertainty...** - dialog for setting and defining the various uncertainty or accuracy input values.

4.2.10 Window

- **Cascade** - arrange windows as overlapped.
- **Tile** - arrange windows as side-by-side.
- **Arrange Icons** - arrange minimized window icons.

4.2.11 View

- **Tool Bar** - view/hide toolbar graphic below the main menu bar.
- **Status Bar** - view/hide status bar at the bottom of the main screen.

4.2.12 Help

- FE-Sizer Help Contents - opens the FE-Sizer Help system contents.
- FE-Sizer Help - opens the FE-Sizer Help system at the top-level Index screen.
- About FE-Sizer - displays a dialog box that shows software version and registered owner.

4.3 Pop-up Menus

Several of the menu bar menu items open a *pop-up menu* for making additional selections. Figure 4-2 gives an example of a pop-up menu list. You choose an item from a menu list by moving the mouse until the pointer points to the menu item you want and clicking the left mouse button to select. Alternatively, you can hold the left mouse button down while dragging the selection cursor down the menu list releasing the mouse button once the desired item is highlighted.

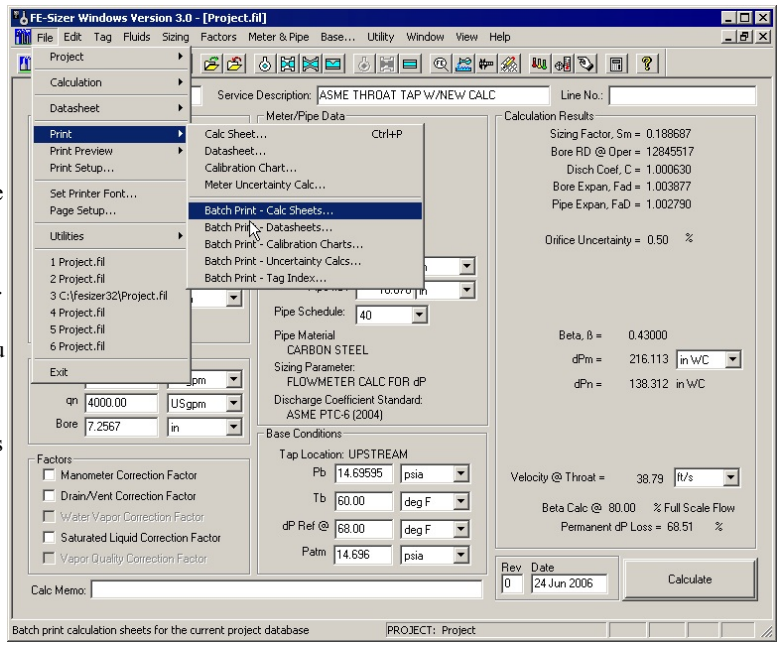


Figure 4-2

4.4 Drop-Down List Boxes

FE-Sizer uses *drop-down list boxes* for selecting additional features or options. Figure 4-3 gives an example of a drop-down list for *Plate Material Selection* to select the material for an orifice plate. A drop-down list box appears initially as a rectangular box containing the current selection. When you select the down arrow in the square box at the right, a list of available choices appears. If there are more items than can fit in the box, scroll bars are provided. To use the scroll bar, click the up or down arrow, or drag the scroll box until the item you want to select is displayed.

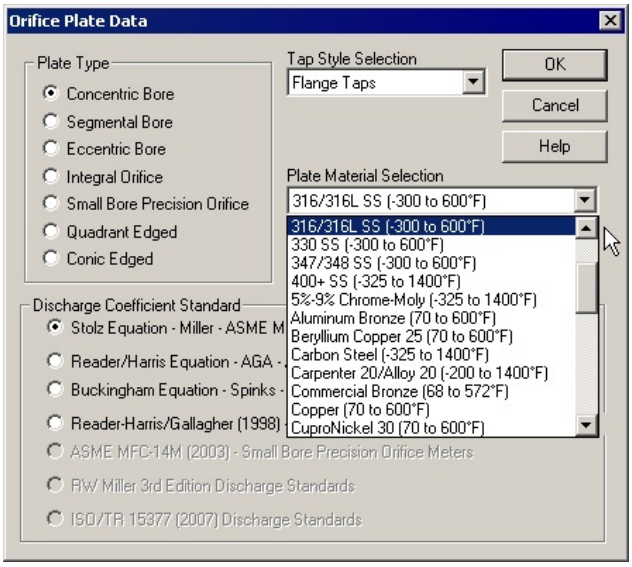


Figure 4-3

4.5 Dialog Boxes

Sometimes, invoking a menu command activates a *dialog box.* An ellipsis (...) after a menu command indicates that a dialog box will appear when you choose that command. FE-Sizer uses dialog boxes to enter data, such as printer commands, user data, etc. Figure 4-4 shows an example of the dialog box opened for printer setup from the *File* menu. Often you need to move within a dialog box to select one or more options. The currently selected option is marked by the selection cursor, which appears as a dotted rectangle, a highlight, or both. To move within a dialog box, click the option or area you want to move to. Or press TAB to move clockwise or SHIFT+TAB to move counterclockwise through the options or areas. If the option, box, or button has an underlined letter in its name, you can choose that item by pressing and holding down the ALT key while typing the underlined letter.

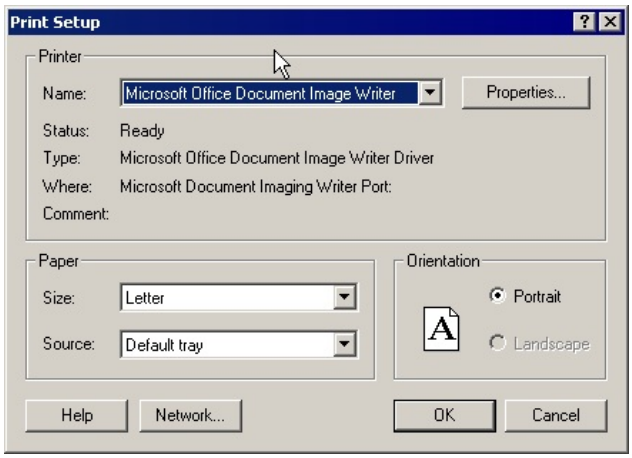


Figure 4-4

4.6 Text Boxes

FE-Sizer uses *text boxes* or *edit boxes* to enter text or numeric data. Text boxes appear in dialog boxes or in the various sections of the main screen. When you move to an empty text box, an *insertion point* (a flashing vertical bar) appears. The text you type starts at the

insertion point. If the box you move to contains text or numeric data, and the data is highlighted, any key you type will replace it. Refer to Section 4.7 for more information regarding editing keys for input fields.

4.7 Keyboard Shortcuts

Key	Function
Alt+C	Closes a project database.
Alt+D	Deletes a tag record from the project database via the Project Tag Selection dialog.
Alt+R	Retrieves a tag record from the project database via the Project Tag Selection dialog.
Ctrl+Alt+C	Clears current calculation data from memory and screen.
Ctrl+Alt+D	Clears all datasheet data for the current tag number record without deleting the calculation data.
Ctrl+Alt+S	Refreshes current project settings to the active project database file.
Ctrl+Alt+V	Previews current calculation sheet for printing.
Ctrl+B	Automatic batch calculation for all records within a project database.
Ctrl+C	Copies current tag record into memory for pasting into another file.
Ctrl+D	Activates Part 1 of datasheet entry dialog.
Ctrl+E	Exports project records to an ASCII delimited data file via the Export Project dialog box.
Ctrl+I	Imports project records from an ASCII delimited data file via the Import Project dialog box.
Ctrl+N	Creates a new project database file via the New Project File dialog.
Ctrl+O	Opens a project database file via the Project Open dialog.
Ctrl+P	Activates the Print dialog box to print the current calculation.
Ctrl+S	Saves current tag record data to project database.
Ctrl+V	Pastes calculation data previously copied to memory into the current calculation.

4.8 Tool Bar

The Tool Bar, illustrated above, is the graphic icon bar found underneath the FE-Sizer Menu Bar. Moving the mouse over one of the icons and clicking the left mouse button activates a given task. Note that the above example shows the Critical Drop Orifice Plate and Critical Drop Nozzle icons as disabled as the current sizing mode is for flow meter sizing. Should the current sizing mode be set to a critical drop sizing selection, these items would be enabled and the flow meter sizing selections would be disabled.

The available tasks from the Tool Bar and their associated section reference number in the manual are as follows...

Open project database - Section 5.1.1

Define customer data.

Clear all data from current screen.

Copy current tag record to memory - Section 5.2.1

Paste tag record from memory to current project- Section 5.2.2

Preview output for the current calculation - Section 5.14

Print the current calculation - Section 5.1.4

Retrieve tag record from project database - Section 5.3.2

Save tag record to project database - Section 5.3.3

Orifice plate data - Section 5.7.1

Flow nozzle data - Section 5.7.1

Venturi data - Section 5.7.1

Critical drop orifice plate data - Section 5.7.1

Critical drop flow nozzle - Section 5.7.1

Pipe data - Section 5.7.2

Set input focus to tag data section - Section 5.3.1

Set input focus to fluid data section - Section 5.4.1

Set input focus to sizing data section - Section 5.5.1

Datasheet data entry - Section 5.1.3

Select fluid

Base condition data - Section 5.8

Setup calculation - Section 5.5.2

Calculate the sizing parameter

About FE-Sizer - Section 5.12

4.9 Status Bar

The status bar shown above is displayed at the bottom of the *sizing screen*. To display or hide the status bar, use the Status Bar command from the View menu.

The left area of the status bar describes actions of menu items as you use the arrow keys or mouse to navigate through the menus.

The right areas of the status bar indicate calculation status, project status, or which keyboard keys are latched down as follows:

Status Indicator	Description
PROJECT	Shows the current project name opened. Displays CLOSED if no project open.
CALC	When text “CALC” visible in status bar, sizing parameter requires calculation. This status area is blank when sizing parameter calculated.
SAVE	When text “SAVE” visible in status bar, calculation requires saving to the project database. This status is blank when record saved to project database.
CAP	The Caps Lock key is latched down.
NUM	The Num Lock key is latched down.

5. FLOW METER SIZING

After the initial title screen, FE-Sizer presents the *sizing screen* and *menu bar* shown in Figure 5-1. The menu bar at the very top of the screen contains twelve menu titles which you can pull down any time. The menu titles are:

- File
- Edit
- Tag
- Fluid
- Sizing
- Factors
- Meter/Pipe
- Base...
- Utility
- Window
- View
- Help

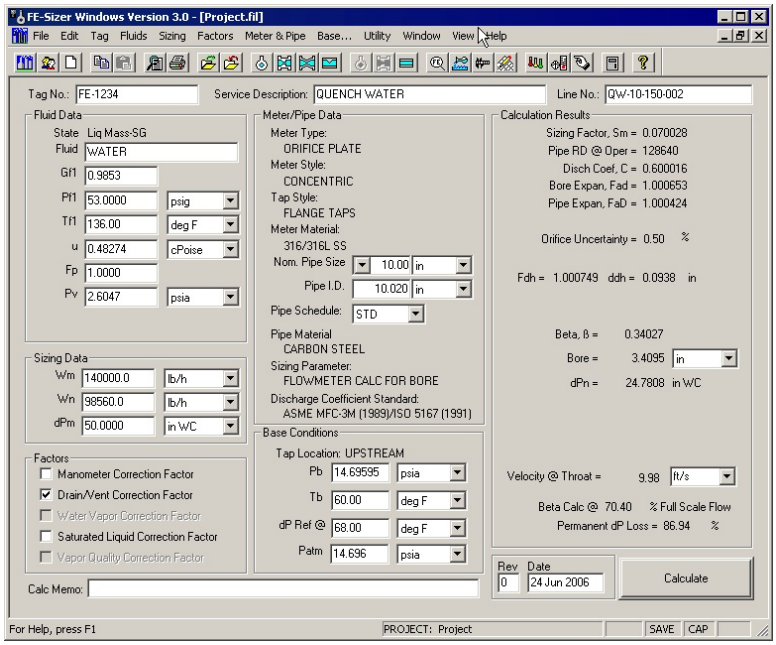


Figure 5-1

Each item from the menu bar either opens a *pull-down* menu where you can select additional features or activates a dialog box to setup program variables and parameters, i.e., *Base* menu item. Some pull-down menus open pop-up menus for making additional selections

5.1 Files

The File menu of Figure 5-2 shows an example of the active pull-down menu. The commands available from this menu are:

Displays the Project pop-up menu.

Displays the Calculation pop-up menu.

Displays the Datasheet pop-up menu.

Displays the Print pop-up menu.

Displays the Print Preview pop-up menu.

Activates the Print Setup dialog box...

Activates the Font Selection dialog box...

Activates the Page Setup dialog box

Displays the Utilities pop-up menu.

Displays the most recently opened files.

Exits the FE-Sizer application.

Figure 5-2

Each of these menu items are described in detail in the sections that follow..

5.1.1 Project

Use the *Project* pop-up menu from the Files menu for accessing project databases. Selecting this item activates the pop-up menu illustrated in Figure 5-3. From this menu you select the following options:

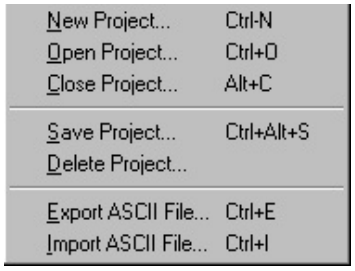


Figure 5-3

Activates the New Project dialog box.
Activates the Open Project dialog box.
Closes the active project.
Saves current settings to active project.
Activates the Delete Project dialog box.
Activates the Export Project dialog box.
Activates the Import Project dialog box.

New Project... Ctrl+N

The *New P*roject command allows you to create a new project database to store calculation records. Selecting this command activates the New Project File dialog box similar to the Open File dialog box illustrated in Figure 5-4. Through this dialog box you enter the project filename for the new project database to create. Alternatively, you can select an existing database from the list box of files from the dialog and FE-Sizer will refresh the project header information with your current settings. You will not lose any existing calculations when refreshing the project settings, i.e., units system, client data, user name, etc.

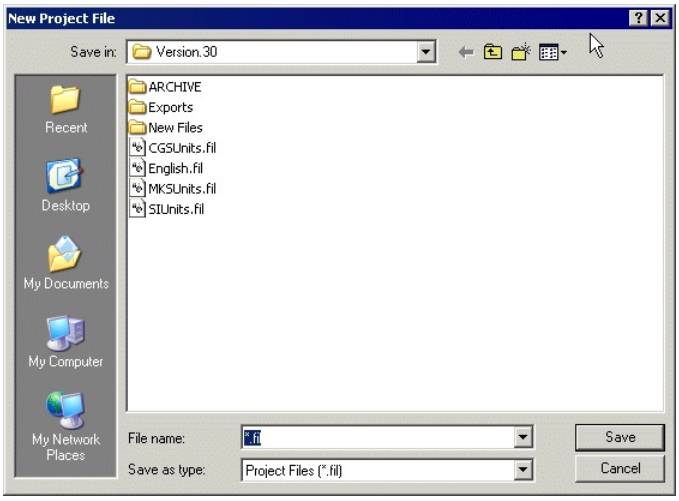


Figure 5-4

The following options are available from this dialog box:

File Name

Type or select the project filename you want to save. This box lists files with the extension you select in the List Files of Type box.

Save as Type

Select the type of file you want to save:

[*.fil] - Project database files are defined for FE-Sizer.

Save in

Select the directory or folder where FE-Sizer stores the project database file that you want to open.

Save Button

Select the **Save** button to save the project database file.

Cancel Button

Select the **Cancel** button to cancel the New Project command.

Once you select the project filename you enter the customer information in the Customer Data dialog box shown in Figure 5-5. Here you enter the name of the client, project, location of the project, job order or purchase order number, and any calculation number assigned to the project. Press the **OK** button once this information is defined to save this information with the project data.

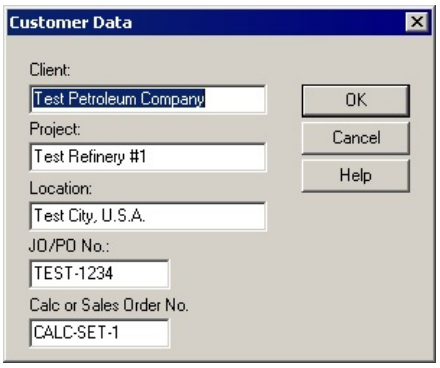


Figure 5-5

Open Project... Ctrl+O

Choose the *Open Project* item from the Project pop-up menu of Figure 5-3 to open an existing project database. The *Ctrl+O* keyboard combination shown to the right of the menu topic is the keyboard shortcut for quickly accessing this menu item from almost anywhere in FE-Sizer. Refer to Section 4.7 for a complete list of keyboard shortcuts in FE-Sizer.

This command activates the *Open Project File* dialog box similar to that illustrated in Figure 5-4 for *New* projects. From this dialog box you select the project database to open.

Close Project... Alt+C

The *Close Project* item from the Project pop-up menu immediately closes any open or active project database.

Save Project... Ctrl+S

Select *Save Project* to refresh the current project information to the current project database. You will be asked to confirm whether to continue with the refresh. Press the "Yes" button to continue or the "No" button to cancel the refresh and return to the sizing screen.

Delete Project...

Use the *Delete Project* dialog box to permanently delete project database files from disk storage. The option opens a similar file selection dialog box illustrated in Figure 5-4. Once you select the project to delete, FE-Sizer displays the *Confirm Project File Delete* dialog box and pick list given in Figure 5-6.

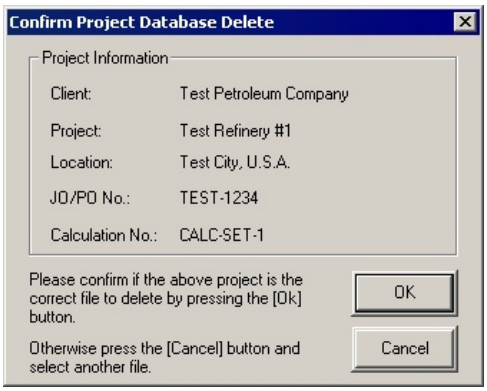

Confirm Project Database Delete
Project Information
Client: Test Petroleum Company
Project: Test Refinery #1
Location: Test City, U.S.A.
JO/PO No.: TEST-1234
Calculation No.: CALC-SET-1
Please confirm if the above project is the correct file to delete by pressing the [Ok] button.
Otherwise press the [Cancel] button and select another file.
OK
Cancel

Figure 5-6

Select the **OK** button to confirm the project database select. The **Cancel** button aborts the Delete Project command.

Export ASCII File... Ctrl+E

The *Export ASCII File* command allows you to export a project database in a conventional ASCII delimited file format. This allows you to interface FE-Sizer project database files with external databases or spreadsheet programs. When you activate this command, FE-Sizer displays the *Export Project File* dialog. The description of the options for this dialog box are similar to those presented for Figure 5-4. Please refer to the *New Project File* command and this figure for details on using this dialog box.

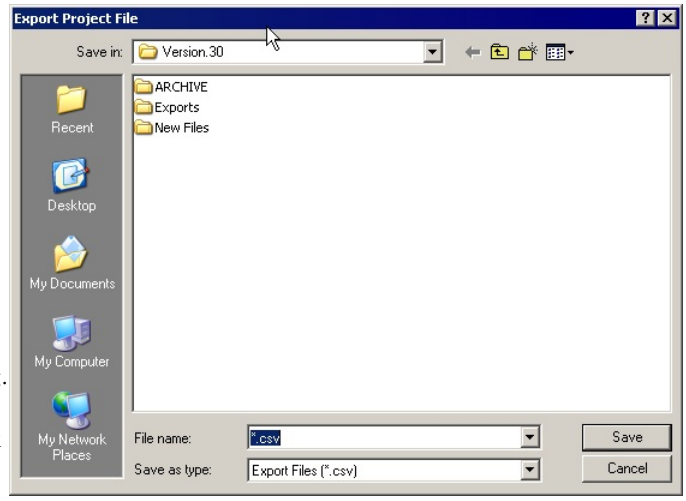


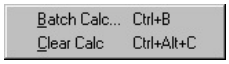
Figure 5-7

Import ASCII File... Ctrl+I

The *Import ASCII File* command allows you to import project database data via a conventional ASCII delimited file. When you activate this command, FE-Sizer displays the *Import Project File* dialog for selecting the import data file. The description of the options for this dialog box are similar to those presented for the "New Project File" command and dialog box of Figure 5-4. Please refer to the description for this dialog box for reference.

For additional information regarding the exporting and importing of project databases, please refer to Section 8.

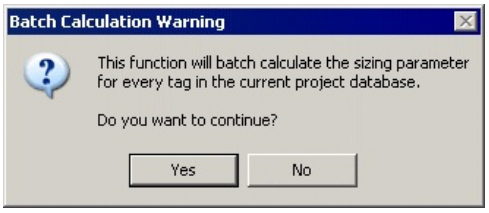
5.1.2 Calculation



Calculation Menu

The *Calculation* pop-up menu item displayed at right allows you to *Batch* calculate project databases or clear calculation data for the current tag number record. This item is accessed through the *File* menu of Figure 5-2.

Batch Calc... Ctrl+B

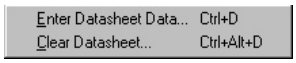

Batch Calculation Warning
This function will batch calculate the sizing parameter for every tag in the current project database.
Do you want to continue?
Yes
No
Batch Calc Command

The *Batch Calc* command at right is used to automatically recalculate all calculation records stored in a project database. As it recalculates the data, a *check file* is saved to disk that gives the status of each calculation performed. This file is saved under the project file name with the extension of ".chk". You can view this file with any ASCII text file viewer to determine the results of the batch calculation.

Clear Calc

This command clears all data for the current tag record.

5.1.3 Datasheet



Datasheet Menu

Use the *Datasheet* pop-up menu from the File menu to enter data sheet information or clear data sheet data for the current tag number record.

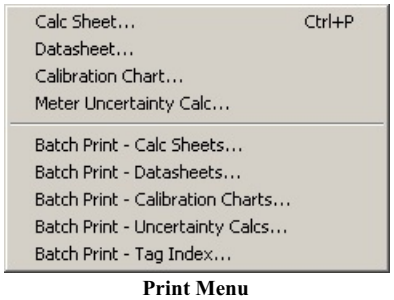
Enter Datasheet Data... Alt+E

This menu item will activate the *Datasheet Entry - Part 1 of 3* dialog box for entering the data for the flow meter data sheet. Please refer to Section 7 for more information regarding creating and maintaining data sheets with FE-Sizer.

Clear Datasheet

The *Clear Datasheet* command clears all data sheet data for the current tag number record without deleting the calculation data.

5.1.4 Print



Print Menu

The *Print* pop-up menu at right consist of the following selections from which you may choose to print various reports and data sheets in FE-Sizer . . .

Calc Sheet

The *Calc Sheet* menu command prints a calculation sheet for the current tag

Datasheet

The *Datasheet* menu command prints a data sheet for the current tag

Calibration Chart

The *Calibration Chart* menu command prints a calibration chart for the current tag

Meter Uncertainty Calc

The *Meter Uncertainty Calc* menu command prints a meter uncertainty calc sheet for the current tag

Batch Print - Calc Sheets

Use the *Batch Print - Calc Sheets* menu command to print all the calculation sheets for the current project database. It opens the *Batch Print* dialog box illustrated in Figure 5-8 where you select the tag records for printing calculation sheets.

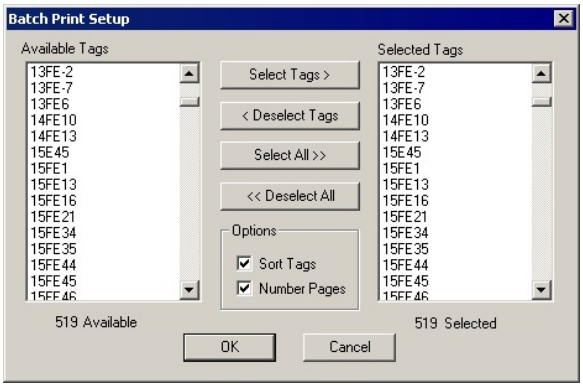


Figure 5-8

This dialog has the following lists, command buttons, and options to setup the various pre-defined reports and data sheets . . .

Available Tags
List box where all available tags for the current project are displayed for selecting.

Selected Tags
List box that shows all tags selected for current project.

Deselect All
Command button to delete all tags from the "Selected Tags" list box.

Deselect Tags
Command button to delete the selected tag(s) from the "Selected Tags" list box.

Select All
Command button to add all tags from the "Available Tags" list box the "Selected Tags" list box.

Select Tags
Command button to add only the selected (highlighted) tag(s) from the "Available Tags" list box to the "Selected Tags" list box.

OK

Command button to add all tags in the "Selected Tags" list box to the batch print Que.

Cancel

Command to empty the batch print que and cancel the batch print command.

Sort Tags

Options check box that switches the sort function on and off. This function sorts all tags for the batch print que to print records in alpha-numeric order.

Number Pages

Options check box that switches the automatic page numbering function on and off. This function consecutively numbers the printed calculation sheet, data sheet, uncertainty calc, etc., in numerical order.

Batch Print - Datasheets

This item is used to print all the data sheets for the current project database. It activates the *Batch Print* dialog box illustrated in Figure 5-8 where you select the tag records for printing data sheets. Refer to the topic for printing calculation sheets above for a detailed description for the *Batch Print* dialog box.

Batch Print - Calibration Charts

This item is used to print all the calibration charts for the current project database. It activates the *Batch Print* dialog box illustrated in Figure 5-8 where you select the tag records for printing data sheets. Refer to the above topic for printing calculation sheets for a detailed description for the *Batch Print* dialog box.

Batch Print - Uncertainty Calcs

This item is used to print all the uncertainty calculations for the current project database. It activates the *Batch Print* dialog box illustrated in Figure 5-8 where you select the tag records for printing data sheets. Refer to the above topic for printing calculation sheets for a detailed description for the *Batch Print* dialog box.

Batch Print - Tag Index

The *Batch Print - Tag Index* menu command activates the *Batch Print* dialog illustrated in the previous Figure 5-8. This command allows you to setup FE-Sizer's *Tag Index* standard report for listing all the records in a project database in the form of an indexed listing. Refer to the above topic for printing calculation sheets for a detailed description for the *Batch Print* dialog box.

5.1.5 Print Preview Pop-up Menu

The *Print Preview* pop-up menu item allows you to preview any of the defined reports for FE-Sizer. The menu items and their functionality are identical to the Print Pop-up Menu description given in Section 5.1.4. Refer to this section for description and details regarding this menu option.

5.1.6 Print Setup

The *Print Setup* menu item activates the printer dialog similar to that shown in Figure 5-8. Use this dialog to select a printer and a printer connection. For this dialog, you specify the printer and its connection by setting up the following options . . .

Printer

Name

Select the printer you want to use by choosing either the Default Printer; or the Specific Printer option and select one of the current installed printers shown in the box.

Properties

Displays a dialog box where you can make additional choices about printing, specific to the type of printer you have selected.

Paper Size

Select the size of paper that the document is to be printed on.

Paper Source

Some printers offer multiple trays for different paper sources. Specify the tray here.

Orientation

Choose Portrait or Landscape.

Network...

When available, choose this button to connect to a network location or assign it a new drive letter.

Since many of these settings are printer-specific, they may not all be available for your particular printer. Consult your Windows documentation and printer manual for more information on these and additional settings.

5.1.7 Utilities Pop-up Menu

Utilities Menu

The *Utilities* selection from the File menu allows you to maintain the project database files. A project must be open before you can select this option from the project menu. For this item, there are two file utilities options which are:

Pack Project Database

The *Pack Project Database* menu item allows you to reclaim space occupied by "deleted" calculations within the project database file. FE-Sizer marks deleted records instead of removing them from the database entirely. This routine compresses the file size by stripping deleted calculations from the project database.

Rebuild Project Index

This selection rebuilds the project database index file (project file name with the extension ".idx"). This file stores the tag number for each record with the relative offset, in bytes, from the beginning of the project database file (project file name with the

extension ".fdb") and allows FE-Sizer to quickly locate project records. Use this option should the index file become corrupted or lost.

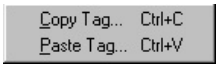
5.1.8 Most Recent Files

In this area of the *Files* menu are the four most recently used project database files. Clicking the mouse on any one of the four files will immediately open that file. FE-Sizer supports up to four most recent files in the *Files* menu.

5.1.9 Exit

You use this menu item when you have finished with FE-Sizer. The Exit command will close all application windows and exit FE-Sizer.

5.2 Edit



Edit Menu

Use the *Edit* menu from the main menu bar for copying and pasting tag records between projects. There are two items are available from this pull down menu.

5.2.1 Copy Tag... Ctrl+C

This item from the Edit menu copies the current tag record for the project into memory for later recall. This is helpful when you need to copy a tag record from one project to another. When the tag data is successfully copied, the Paste button is activated to indicate data exists in the memory buffer ready for pasting.

5.2.2 Paste Tag... Ctrl+V

The *Paste* item from the Edit menu copies the tag data stored to memory from a previous *Copy* command into a new project tag record. Note that you can select this command only when the *Paste* button is active.

5.3 Tag

An example for the *Tag* menu is shown in Figure 5-9. The available commands for this menu are:

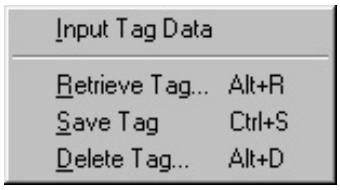


Figure 5-9

Sets input focus to the Tag No. input edit box.

Retrieves a record from the project database.

Saves the current record to the project database.

Deletes a record from the project database.

5.3.1 Input Tag Data

This command sets the input focus to the *Tag No.* edit box underneath the left hand portion of the tool bar. It allows you to quickly select the previous tag (if existing) and replace the text with a new tag number. By pressing the TAB key from the *Tag No.* edit

box, input focus jumps to the *Service Description* and another press jumps input focus to the *Line No.* box.

5.3.2 Retrieve Tag... Alt+R

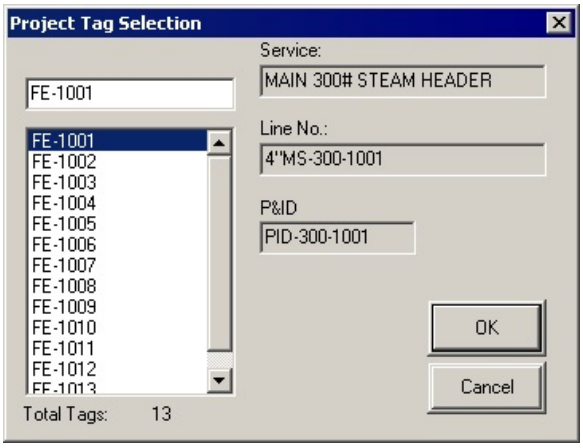


Figure 5-10

The *Retrieve Tag* menu item provides the interface for retrieving calculation records from the project database. This menu item activates the *Project Tag Selection* dialog illustrated in Figure 5-10. For this dialog box, you use the mouse to select a tag record from the scrolling list box. You can also type the desired tag number in the *Tag Number* edit field above the list box. Note that as tags are selected, the *Service*, *Line No.*, and *P&ID* boxes are updated with information to assist you in selecting the appropriate tag number.

Once you select the tag number, press the **OK** button to retrieve the record from the project database. Be sure you have saved any previous calculations prior to retrieving a record from the database to avoid lost data.

To cancel this operation, click **Cancel** with the left mouse button. The record data will reset to the last record prior to activating this dialog box.

5.3.3 Save Tag...Ctrl+Alt+S

The Save Tag menu item inserts the record data of the current calculation into the project database. This item is disabled if there is no project database currently open. For this selection, FE-Sizer saves the calculation data to the project database file and records the calculation tag number in the project database index file, "project.idx," for later retrieval. Should the tag number exist in the database, FE-Sizer prompts if you wish to overwrite the existing data with the new data.

5.3.4 Delete Tag... Alt+D

This option deletes a tag record from the database deleting any existing calculation and data sheet for the selected tag number. FE-Sizer displays the *Project Tag Selection* dialog shown in Figure 5-10. Selecting a tag number to delete is the same procedure as that previously described in Section 5.3.2 for tag retrieval. FE-Sizer requires that you confirm the record data prior to executing the delete command.

5.4 Fluids

You use the *Fluids* menu for defining the fluid property data for meter applications. Figure 5-11 shows an active Fluids menu with a description of each available command.

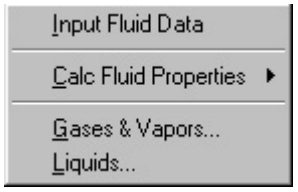


Figure 5-11

Sets focus to the first item of the *Fluid Data screen*.

Activates pop-up menu for property correlation.

Sets the current fluid type to gases & vapors.

Sets the current fluid type to liquids.

Select the desired item by either clicking the left mouse button on the desired option or by using the up or down keyboard cursor to highlight the desired item and pressing the ENTER key to select the item highlighted. Pressing any underscored character on the keyboard immediately selects the associated item while the menu is active.

5.4.1 Input Fluid Data

The command, *Input Fluid Data*, sets the input focus to the first item of the Fluid Data screen section. Pressing the tab key after every entry cycles the focus through every input in the Fluid Data section for the selected fluid. All fluid data must be complete prior to selecting the *Calculate* command. Otherwise, FE-Sizer displays an error message for incomplete data.

5.4.2 Calc Fluid Properties

The *Calc Fluid Properties* pull-down menu activates a pop-up menu where you select the desired fluid. The available fluid selections are displayed in the example *Fluid* menu shown in Figure 5-12. Once you select the desired fluid, FE-Sizer activates the *Single & Multi-Component Fluid Selection* for all fluids except steam and water. For these items you enter the pressure and/or temperature, as required, through an appropriate dialog input box. Refer to Section 8 for more details regarding the fluid property correlations and instructions on how to use them.

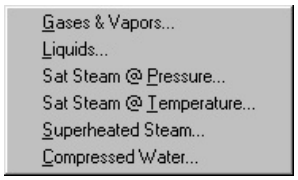


Figure 5-12

5.4.3 Gases & Vapors

This menu item opens the *Gas Equation Setup* dialog Figure 5-13. For this dialog you must select . . .

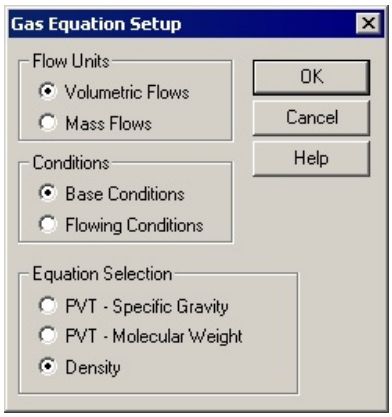


Figure 5-13

Flow Units

Volumetric Flows
Sets the flow units for gas and vapor flows to volumetric units, ie, cubic feet, cubic meters, etc.

Mass Flows
Sets the flow units for gas and vapor flows to mass units, ie, pounds, kilograms, etc.

Conditions

Base Conditions

Sets volume conditions for Standard or Normal (ISO) conditions. Standard conditions are defined as Base Pressure @ 14.69595 psia and Base Temperature @ 60 °F for volumetric flow units. Normal or ISO conditions are Base Pressure @ 1.01325 bar-abs and Base Temperature @ 0 °C. Can also be used to set the base pressure and temperature for Contract conditions for custody sales meters.

Flowing Conditions

Selects flowing conditions or actual conditions for the volumetric flow units.

Equation Selection

PVT - Specific Gravity

Sets the gas vapor sizing equation to use specific gravity as the property input and use the gas property law PV = zRT. Note that specific gravity for a gas is defined as: $MW_{gas} / MW_{air} = MW / 28.9625$.

PVT - Molecular Weight

Sets the gas vapor sizing equation to use molecular weight as the property input and use the gas property law PV = zRT, where *z* is the compressibility for the vapor or gas.

Density Form

Sets the gas vapor sizing equation to use density for the gas/vapor property input.

5.4.5 Liquid-Volume

Select this fluid type for liquid flows. This selection activates the *Liquid Equation Setup* dialog shown in Figure 5-14. For this dialog you must select . . .

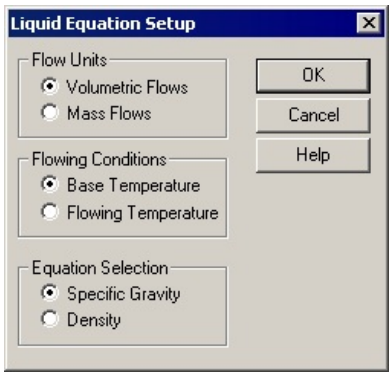


Figure 5-14

Flow Units

Volumetric Flows

Sets the flow units for gas and vapor flows to volumetric units, ie, cubic feet, cubic meters, etc.

Mass Flows

Sets the flow units for gas and vapor flows to mass units, ie, pounds, kilograms, etc.

Conditions

Base Conditions

Sets volume conditions to base condition temperature conditions - 60°F (15.56°C) for the volumetric flow units.

Flowing Conditions

Selects flowing conditions or actual conditions for the volumetric flow units.

Volumetric Equation Selection

Specific Gravity Form

Sets the liquid sizing equation fluid property input to specific gravity defined as:

base condition - density of fluid @ 60 °F / density of water @ 60 °F (15.56 °C).

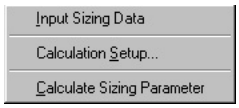
flow conditiion - density of fluid @ temperature / density of water @ flowing temperature.

Density Form

Sets the liquid sizing equation fluid property input to density form, i.e., density @ base condition and/or density @ flow condition.

5.5 Sizing

You use the *Sizing* menu to enter sizing data or setup the calculation mode for FE-Sizer.



Sizing Menu

5.5.1 Input Sizing Data

The *Input Sizing Data* menu command sets the input focus to the first data item for the Sizing Data screen section. Pressing the tab key after each data entry moves the input focus to the next item. Note that this screen section is dynamic and the required data varies with the selected sizing parameter, i.e., bore, differential pressure, or flow.

5.5.2 Calculation Setup

This menu item activates the *Calculation Setup* dialog illustrated in Figure 5-15 to setup calculation modes and sizing parameters for FE-Sizer.

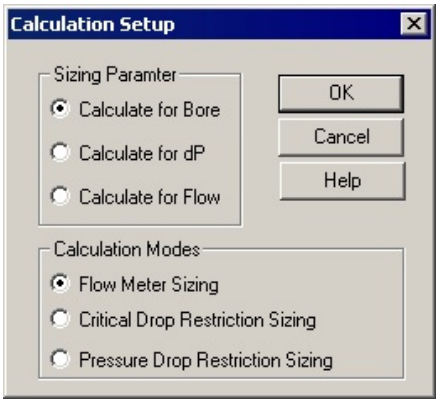


Figure 5-15

Options for this dialog box are . . .

Sizing Parameter

Calculate for Bore

Sets the sizing parameter to calculate the orifice bore given information for flow, differential pressure, etc., for the application.

Calculate for dP

Sets the sizing parameter to calculate the orifice differential pressure given information for flow, bore, etc., for the application.

Calculate for Flow
Sets the sizing parameter to calculate the flow through the orifice given information for bore, differential pressure, etc., for the application.

Calculation Modes

Flow Meter Sizing
Sets the calculation mode to determine the sizing parameter for conventional flow meter applications.

Critical Drop Restriction Sizing
Sets the calculation mode to determine the sizing parameter for a critical drop application. For gases and vapors, critical drop occurs at sonic flow conditions. For liquids, critical drop occurs when a cavitation barrier is present.

Restrictive Pressure Drop Sizing
Sets the calculation mode to calculate the sizing parameter based on pressure restriction.

Click on the respective radio button of each grouping to select the mode.

5.6 Factors

You use the *Factors* menu to select any special sizing factor needed in a meter calculation. The selections for this menu are . . .

Figure 5-16

Activates the *Manometer Correction Factor* dialog.

Activates the *Drain/Vent Hole Selection* dialog.

Activates the *Water Vapor Correction Factor*

Activates the *Saturated Liquid Factor* dialog.

Activates the *Vapor Quality* dialog.

Note that some of the available selections from this menu are disabled or "greyed" as in the *Saturated Liquid* selection shown in the example illustrated by Figure 5-16. The validity of any of the selections vary with the type fluid in question and only valid choices are active for any given fluid type. Invalid choices are disabled.

5.6.1 Manometer Factor (F_M)

For mercury U-tube manometers and mercury-manometer-type differential pressure instruments, the **M**anometer factor, F_M, corrects the sizing parameter for the effect of a gas or liquid column of fluid above the mercury at the static pressure and temperature at the instrument.

When you select the *Manometer* factor from the menu, FE-Sizer displays a dialog box for the

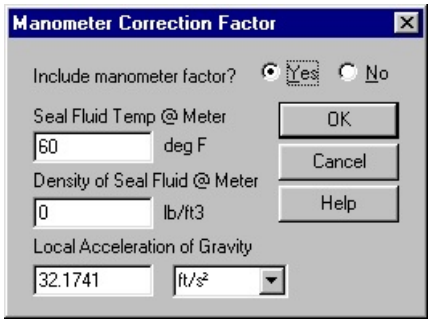


Figure 5-17

manometer correction factor as shown in the example for Figure 5-17. The required inputs for this dialog box are . . .

Include manometer factor?

Select whether to include the manometer factor by clicking on either the "Yes" to activate or "No" disable manometer factor correction.

Seal Fluid Temp @ Meter

Enter the temperature of the seal fluid at the meter location for average ambient conditions. The input must be in the temperature units specified, i.e., deg F, deg C, deg R, deg K

Density of Seal Fluid @ Meter

Enter the density of the seal fluid at the specified temperature and in the specified units for this input.

Local Acceleration of Gravity

Enter the local acceleration of gravity for the meter for the geographical location. The default is 32.1741 ft/s^2.

OK Button

Select the OK button to set up the parameters for the manometer correction factor and close the dialog box.

Cancel Button

Select the Cancel button to close the manometer correction factor dialog box and cancel any changes made.

Help Button

Displays the help topic for the *Manometer Correction Factor* dialog box.

5.6.2 Drain/Vent Hole Factor (F_{DH})

Drain and vent holes prevent the build up of condensate (for vapors) or vapor voids (for liquids) in front of the orifice. This buildup can cause erratic flow measurements. A small hole drilled nearly flush with the inside diameter of the pipe can prevent this condition from occurring. The drain/vent hole factor, F_{dh}, compensates the calculation for the increased flow through the drain or vent hole.

The drain/vent hole factor menu item displays the "Drain/Vent Hole Diameter Selection" dialog box shown in Figure 5-18. This is a dynamic dialog which presents various input boxes based on the selected drain/vent hole factor setup option described as follows:

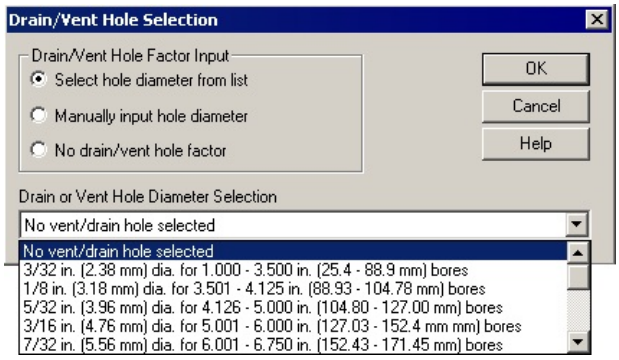

Drain/Vent Hole Selection
Drain/Vent Hole Factor Input
Select hole diameter from list
Manually input hole diameter
No drain/vent hole factor
OK
Cancel
Help
Drain or Vent Hole Diameter Selection
No vent/drain hole selected
No vent/drain hole selected
3/32 in. (2.38 mm) dia. for 1.000 - 3.500 in. (25.4 - 88.9 mm) bores
1/8 in. (3.18 mm) dia. for 3.501 - 4.125 in. (88.93 - 104.78 mm) bores
5/32 in. (3.96 mm) dia. for 4.126 - 5.000 in. (104.80 - 127.00 mm) bores
3/16 in. (4.76 mm) dia. for 5.001 - 6.000 in. (127.03 - 152.4 mm mm) bores
7/32 in. (5.56 mm) dia. for 6.001 - 6.750 in. (152.43 - 171.45 mm) bores

Figure 5-18

Drain/Vent Hole Factor Input

Group of radio buttons to allow you to setup the

drain/vent hole factor. Their captions and definitions are . . .

Select hole diameter from list - Option Button #1
Click this radio button to select drain/vent hole diameter from a drop down list box of standard drain/vent hole diameters.

Manually input hole diameter - Option Button #2
Click this radio button to enter any drain/vent hole diameter manually in an input edit box.

No drain/vent hole factor - Option Button #3
Click this radio button to turn off the drain/vent hole factor.

Drain/Vent Hole Diameter Selection - ***Activated by Option Button #1***
Drop down list box displayed for the "Select hole diameter from list" option and is shown in Figure 5-18 above. This list box shows all the available standard drain/vent hole diameters. Click on the drop down arrow button to the right of the list box or click on the list itself to drop down all available diameters. Use the scroll button to the right of the list box to view all the available selections. Click on the desired diameter to make your selection.

Drain/vent hole diameter - ***Activated by Option Button #2***
Edit box displayed for the *Manually input hole diameter* option (see Figure 5-19). For this input, manually enter any desired drain or vent hole diameter in the indicated units.

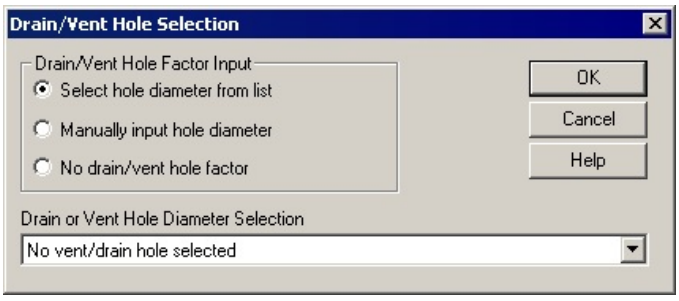


Figure 5-19

OK Button
Select the OK button to set up the parameters for the drain/vent hole factor and close the dialog box.

Cancel Button
Select the Cancel button to close the drain/vent hole factor dialog box and cancel any changes made.

Help Button
Displays the help topic for the *Drain/Vent Selection* dialog box.

5.6.3 Water Vapor Correction Factor (F_{WV})

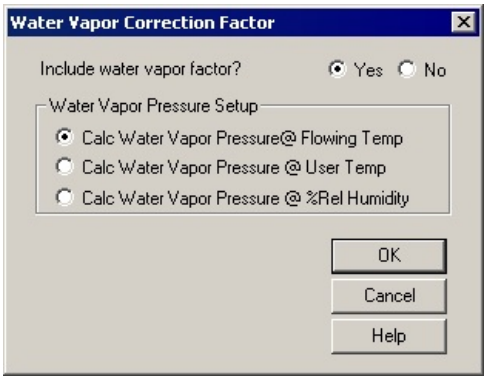


Figure 5-20

This factor is useful for the chemical, air reduction, and other industries when you need to correct the given volume of moist gas flow to a dry condition basis. The dialog box activated by this menu item is presented in Figure 5-20.

The inputs for this dialog box are . . .

Include water vapor factor?

Select whether to include the water vapor factor by clicking on either the *Yes* or *No* radio button.

Water Vapor Pressure Setup

Group of radio buttons to allow you to pick the method for determining the relative humidity of the vapor used in calculating the water vapor correction factor. Their captions and definitions are:

Calc Water Vapor Pressure @ Flowing Temp - Option Button #1

Click this radio button to calculate the relative humidity determined by the water vapor pressure calculated at the actual flowing temperature and pressure at the meter.

Calc Water Vapor Pressure @ User Temp - Option Button #2

Click this radio button to enter the desired temperature for calculating the relative humidity determined by the water vapor pressure calculated at the user specified temperature and flowing pressure at the meter.

Calc Water Vapor Pressure @ % Relative Humidity - Option Button #3

Click this radio button to manually specify the relative humidity of the vapor.

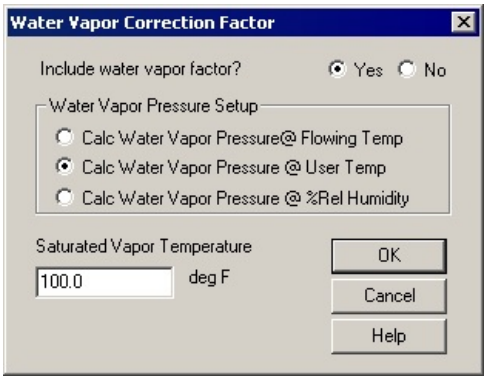


Figure 5-21

Saturated Vapor Temperature - *Activated by Option Button #2*

Refer to Figure 5-21. Enter the desired temperature for determining the relative humidity of the vapor used in calculating the water vapor correction factor.

Relative Humidity - *Activated by Option Button #3*

Refer to Figure 5-22. Enter the desired relative humidity of the vapor used in calculating the water vapor correction factor.

OK Button

Select the OK button to set up the parameters for the water vapor correction factor and close the dialog box.

Cancel Button

Select the Cancel button to close the water vapor correction factor dialog box and cancel any changes made.

Help Button

Displays the help topic for the Water Vapor Correction dialog.

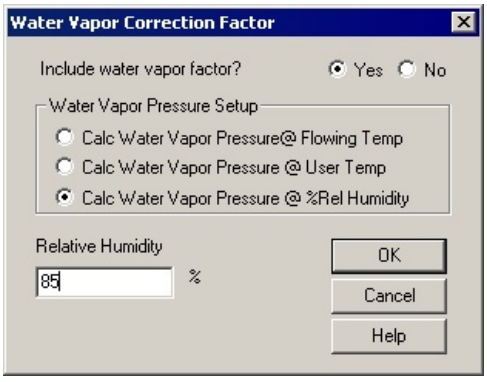


Figure 5-22

5.6.4 Saturated Liquid Factor (F_{SAT})

Use this factor to calculate saturated liquid flows (two phase liquid) where the vapor quality (percentage of vapor mass to total fluid mass) is 10 percent or less. This factor is valid for liquid flows only and is disabled for all other fluid types.

Refer to Figure 5-23 for an example of the *Saturated Liquid Factor* dialog. The inputs are . . .

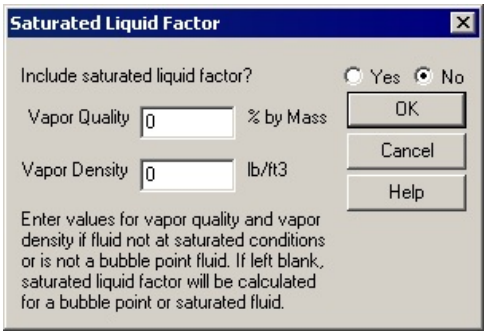

Saturated Liquid Factor
Include saturated liquid factor?
Yes
No
Vapor Quality
0
% by Mass
Vapor Density
0
lb/ft3
OK
Cancel
Help
Enter values for vapor quality and vapor density if fluid not at saturated conditions or is not a bubble point fluid. If left blank, saturated liquid factor will be calculated for a bubble point or saturated fluid.

Figure 5-23

Include saturated liquid factor?
Select to include saturated liquid factor by clicking either *Yes* or *No* radio button.

Vapor Quality
Enter the quality of the vapor portion for the fluid. Quality must be between 0% and 10%.

Vapor Density
Enter the density of the vapor portion for the fluid.

OK Button
Select the OK button to set up the parameters for the saturated liquid factor and close the dialog box.

Cancel Button
Select the Cancel button to close the liquid factor dialog box and cancel any changes made.

Help Button
Displays the help topic for the *Saturated Liquid Factor* dialog box.

5.6.5 Vapor Quality Factor (F_X)

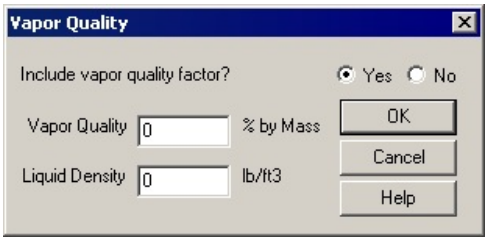


Figure 5-24

The vapor quality factor is used to calculate saturated vapor flows (two phase vapor) where the vapor quality (percentage of vapor mass to total fluid mass) is 90 percent or more. This factor is valid for vapor mass flows only and is disabled for all other fluid types. An example of the active dialog for the *Vapor Quality* factor is shown in Figure 5-24.

The inputs for this dialog box are . . .

Include vapor quality factor?
Select whether to include the vapor quality factor by clicking on either the *Yes* or *No* radio button.

Vapor Quality

Enter the quality of the vapor portion for the fluid. Quality must be between 90% and 100%.

Liquid Density

Enter the density of the liquid portion for the fluid.

OK Button

Select the **OK** button to set up the parameters for the vapor quality factor and close the dialog box.

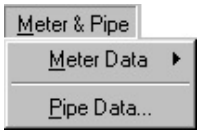
Cancel Button

Select the **Cancel** button to close the vapor quality factor dialog box and cancel any changes made.

Help Button

Displays the help topic for the *Vapor Quality* dialog.

5.7 Meter/Pipe



Meter & Pipe Menu

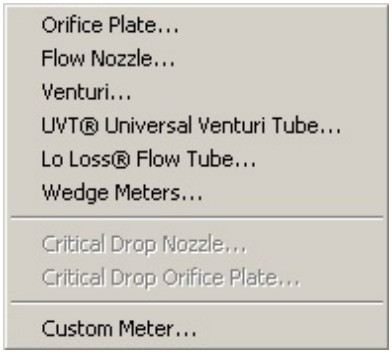
The *Meter/Pipe menu* illustrated at right is used to enter all meter and pipe data. The selections available for this menu are . . .

Meter Data - activates the pop-up menu for selecting the meter type.

Pipe Data - activates a dialog box for defining the meter piping.

5.7.1 Meter Data

The *Meter Data* pop-up menu is used to set the meter type and various meter settings to define the flow meter application. Figure 5-25 shows the menu along with a brief description of each of the available selections from this menu.



Dialog to setup parameters for *Orifice Plates*
Dialog to setup parameters for *Flow Nozzles*
Dialog to setup parameters for *Venturi*
Dialog to setup materials for *U.V.T.* meters
Dialog to setup materials for *Lo Loss Flow Tubes*
Dialog to setup parameters *for Wedge* meters
Dialog to setup *Critical Drop Nozzles* data
Dialog to setup *Critical Drop Orifice Plate* data
Activates *Custom Meter Selection* dialog.

Figure 5-25

Orifice Plate...

The *Orifice Plate Data* dialog represented in Figure 5-26 is used to define orifice plate type flow elements. Through this dialog you set various parameters to define the characteristics for the orifice flow meter.

The parameters to set are . . .

Plate Type

This group of option buttons is where you set the orifice plate design for the current meter application. Simply click the left mouse button on the desired orifice plate type. The plate styles to select from are . . .

Concentric Bore
circular bore centered in the center of a flat circular plate.

Segmental Bore
bore shaped as a segment of a circular an located either with the segment portion up or down within the meter pipe.

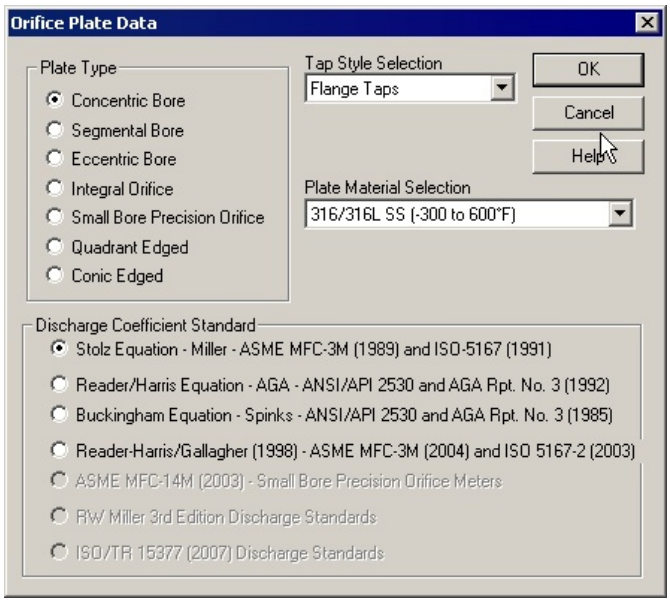

Orifice Plate Data
Plate Type
Concentric Bore
Segmental Bore
Eccentric Bore
Integral Orifice
Small Bore Precision Orifice
Quadrant Edged
Conic Edged
Tap Style Selection
Flange Taps
OK
Cancel
Help
Plate Material Selection
316/316L SS (-300 to 600°F)
Discharge Coefficient Standard
Stolz Equation - Miller - ASME MFC-3M (1989) and ISO-5167 (1991)
Reader/Harris Equation - AGA - ANSI/API 2530 and AGA Rpt. No. 3 (1992)
Buckingham Equation - Spinks - ANSI/API 2530 and AGA Rpt. No. 3 (1985)
Reader-Harris/Gallagher (1998) - ASME MFC-3M (2004) and ISO 5167-2 (2003)
ASME MFC-14M (2003) - Small Bore Precision Orifice Meters
RW Miller 3rd Edition Discharge Standards
ISO/TR 15377 (2007) Discharge Standards

Figure 5-26

Eccentric Bore
circular bore bored off-center (or eccentrically) from the center of a flat circular plate.

Integral Orifice
consists of an orifice plate installed integrally with a differential pressure transmitter.

Honed Meter Run
small bore pipe meter run consisting of upstream and downstream honed pipe sections, orifice flanges and concentric bore orifice plate.

Quadrant-edged
orifice plate with an entrance profile defined as a quadrant radius**.**

Conic-edged
orifice plate with a conical entrance profile.

Tap Style Selection

Drop down list box used to define the type of taps for the orifice assembly. This list dynamically updates with the valid options for the selected orifice plate type. To view the list, either click the left mouse button on the drop down arrow to the right of the list box or on the list itself. Click the left mouse button on the desired tap style to select.

Plate Material Selection

Drop down list box that lists all the available orifice materials. To view the list, either click the left mouse button on the drop down arrow to the right of the list box or on the list itself. Click the left mouse button on the desired material to select.

Discharge Coefficient Standard

Option button grouping used to select the orifice standard for calculating the discharge coefficient. Select the desired standard by clicking on it with the left mouse button.

Flow Nozzle...

Figure 5-27 shows an example of the *Flow Nozzle Data* dialog. To define the nozzle you must select . . .

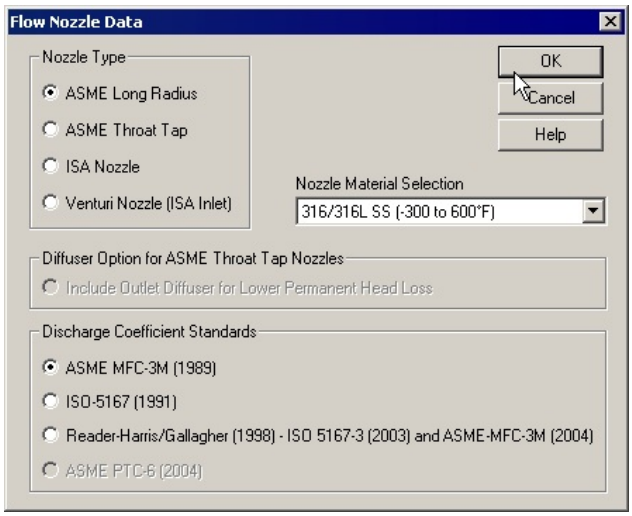


Figure 5-27

Nozzle Type

Group of options where you select the nozzle type. Available choices are . . .

ASME Long Radius

nozzle fabricated with an elliptically shaped contoured inlet formed from the quadrant of an ellipse.

ASME Throat Tap

manufactured from the ASME long-radius nozzle by the addition of diametric throat taps

ISA Nozzle

nozzle fabricated with a double-radius contoured inlet and provided with corner taps

Venturi Nozzle - (ISA Inlet)

fabricated from an ISA 1932 nozzle that is fitted with a venturi divergent downstream exit cone to reduce overall pressure loss

Nozzle Material Selection

Drop down list box that lists all the available nozzle materials. To view the list, either click the left mouse button on the drop down arrow to the right of the list box or on the list itself. Click the left mouse button on the desired material to select.

Discharge Coefficient Standard

Option button grouping used to select the orifice standard for calculating the discharge coefficient. Select the desired standard by clicking on it with the left mouse button.

Venturi Data...

The *Venturi Data* dialog is illustrated in Figure 5-28. This dialog gives the following parameters from which you must select . . .

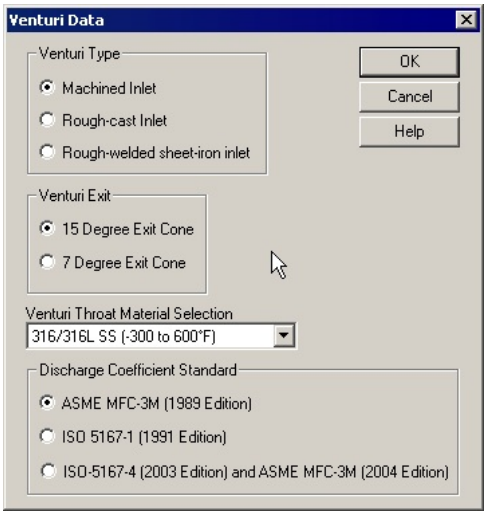


Figure 5-28

Venturi Type

Group of options for setting the venturi type. Available choices are:

Machined inlet

recommended for line sizes of 4 to 32 inches (100 to 800 mm).

Rough-cast inlet

recommended for line sizes of 2 to 10 inches (50 to 250 mm).

Rough-welded sheet-iron inlet

recommended for line sizes of 8 to 48 inches (200 to 1200 mm).

Venturi Exit

Group of options you use to select the venturi exit cone. Available choices are:

15 Degree Exit Cone

Ssorter cone length due to the greater exit angle. It generally has a higher permanent pressure loss.

7 Degree Exit Cone

longer cone length due to the lesser exit angle. It has a lower permanent pressure loss.

Venturi Throat Material Selection

Drop down list box that lists all the available venturi throat materials. To view the list, either click the left mouse button on the drop down arrow to the right of the list box or on the list itself. Click the left mouse button on the desired material to select.

Discharge Coefficient Standard

Option button grouping used to select the orifice standard for calculating the discharge coefficient. Select the desired standard by clicking on it with the left mouse button.

Universal Venturi Tube...

Figure 5-29 illustrates an example of the *Universal Venturi Tube Material Selection* dialog. For this meter type you select only the material type.

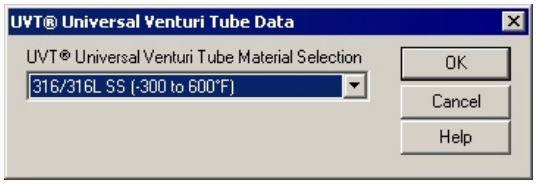


Figure 5-29

Lo Loss Flow Tube...

The dialog for *Lo Loss Flow Tube Material Selection* is similar in display and operation to that shown in Figure 5-29 for Universal Venturi Tubes.

Wedge Meter Selection...

The *Wedge Meter Selection* dialog is illustrated in Figure 5-30. This dialog gives the following parameters from which you must select . . .

Wedge Meter Type

Group of options for setting the wedge meter type. Available choices are:

Generic Wedge Meter

non-proprietary wedge meter design with estimated ± 2 percent results for discharge coefficient calculation.

ABB Model 1610L Wedge thru 1337L Integral Wedge

Proprietary wedge meter design for ABB-Taylor wedge meters with reported ± 0.5 percent accuracy or uncertainty.

Wedge Meter Material Selection

Drop down list box that lists all the available wedge meter materials. To view the list, either click the left mouse button on the drop down arrow to the right of the list box or on the list itself. Click the left mouse button on the desired material to select.

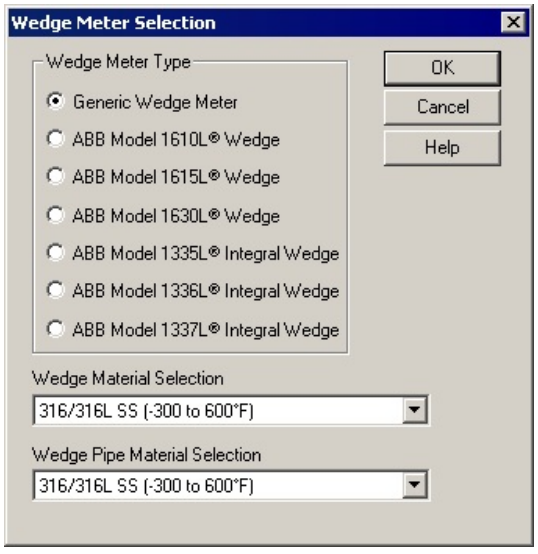


Figure 5-30

Wedge Pipe Material Selection

Drop down list box that lists all the available wedge meter pipe materials. To view the list, either click the left mouse button on the drop down arrow to the right of the list box or on the list itself. Click the left mouse button on the desired material to select.

Critical Drop - Nozzle...

Figure 5-31 is an active dialog for *Critical Drop Nozzle Data*. The menu item that activates this dialog is normally disabled for all calculation modes except *critical drop sizing*. The parameters you select to define the critical drop nozzle are . . .

Nozzle Type

Options grouping you use to select the critical drop nozzle type. Available choices are:

ASME Long Radius/ISO Cylindrical Nozzle

ISO Toroidal Nozzle

Nozzle Material Selection

Drop down list box that lists all the available critical drop nozzle materials. To view the list, either click the left mouse button on the drop down arrow to the right of the list box or on the list itself. Click the left mouse button on the desired material to select.

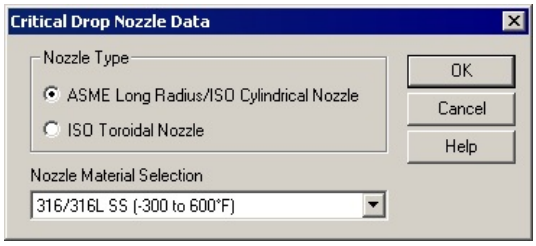


Figure 5-31

Critical Drop - Orifice Plate...

This meter type menu selection activates the *Critical Drop Orifice Plate Data* dialog illustrated in Figure 5-32. Like critical drop nozzles, this menu item is disabled unless the critical drop sizing mode has been selected. For this dialog, you define the following . . .

Plate Type

Group of options you use to select the critical drop orifice plate type. Available choices are . .

Square-edged orifice plate

Thick orifice plate

Plate Material Selection

Drop down list box that lists all the available critical drop orifice materials. To view the list, either click the left mouse button on the drop down arrow to the right of the list box or on the list itself. Click the left mouse button on the desired material to select.

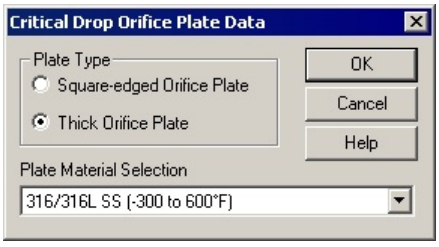


Figure 5-32

Custom Meter...

You use the *Custom Meter* menu item to define the parameters for a custom or "calibrated" meter run. It allows you to manually set the discharge coefficient that is used in the

calculation. An example for the *Custom Meter Selection* dialog is given in Figure 5-33. To properly define a custom meter, you must set the following parameters . . .

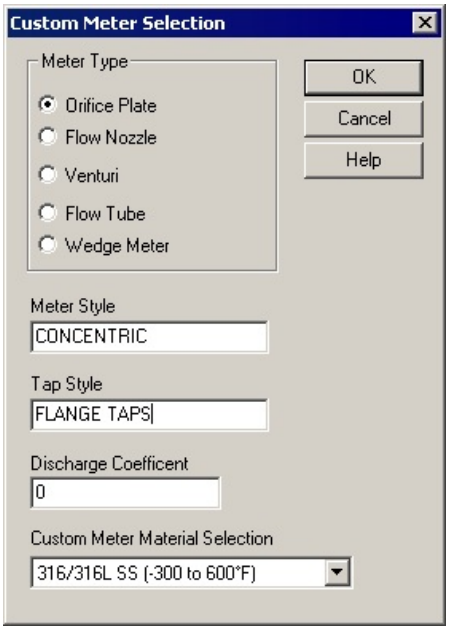


Figure 5-33

Meter Type

Group of options you use to select the meter type. Available choices are:

Orifice Plate

Flow Nozzle

Venturi

Flow Tube

Wedge Meter

Meter Style

Text box where you enter a description for meter style, e.g., concentric bore, classical, etc.

Tap Style

Text box where you define the tap style required, e.g., flange taps, corner taps, etc.

Discharge Coefficient

Input box for entering or specifying the discharge coefficient for the meter

Custom Meter Material Selection

Drop down list box that lists all the available materials. To view the list, either click the left mouse button on the drop down arrow to the right of the list box or on the list itself. Click the left mouse button on the desired material to select.

5.7.2 Pipe Data

The menu item for *Pipe Data* activates the dialog shown in the following Figure 5-34. This dialog box is used to specify all upstream and downstream piping data for a flow meter. The required parameters for the *Pipe Data* dialog
are. . .

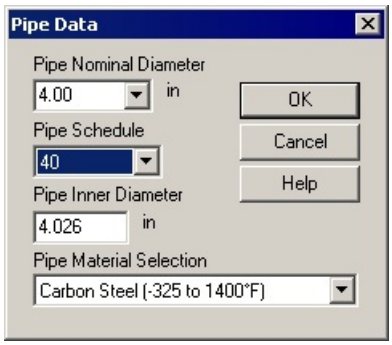


Figure 5-34

Pipe Nominal Diameter

Input box for entering the nominal pipe diameter in the specified units.

Pipe Schedule

Drop down list box for selecting the pipe schedule.

Pipe Inner Diameter

Input box for entering pipe inner diameter in the specified units.

Pipe Material Selection

Drop down list box that lists all the available materials. To view the list, either click the left mouse button on the drop down arrow to the right of the list box or on the list itself. Click the left mouse button on the desired material to select.

5.8 Base...

The *Base* menu item allows you to set the base conditions for the calculation, i.e., pressure tap location, the values for base temperature and base pressure, dP reference temperature and the atmospheric pressure. This menu item activates the *Base Condition Data* dialog shown in the example of Figure 5-35. For this dialog, you set the following parameters to define the base condition . . .

Pressure Tap Location

Select between upstream and downstream pressure tap location via this options button grouping. You should note that this parameter only affects the calculated bores for those equations that use the expansion factor correction, i.e, gases and vapors.

Base Pressure

Enter the base or "contract" pressure for this input. The U.S. standard base condition and ISO normal base condition pressure is 14.69595 psia (101.325 kPA(Abs).

Base Temperature

Enter the base or "contract" temperature for this input. The U.S. standard base condition temperature is 60°F and normal conditions temperature for ISO conditions is 0°C.

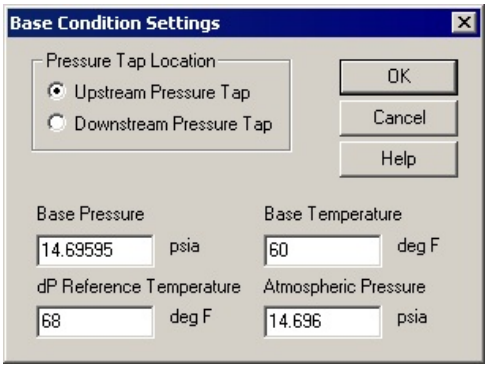


Figure 5-35

dP Reference Temperature

Enter the temperature for the density of water used in determining the head or differential across the meter.

Atmospheric Pressure

Enter the annual average atmospheric or barometric pressure for the geographic location where the meter is installed.

To the right of the radio button group for pressure tap location are three selection buttons (OK, Cancel, and Help). Their functions are . . .

OK

Once you select the **OK** button, the base condition variables are set for the next calculation.

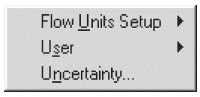
Cancel

If you desire to cancel any changes made to the above information, click on the **Cancel** button.

Help

Displays the help topic for the base condition dialog.

5.9 Utility



Utility Menu

The *Utility* pull-down menu shown at right enables you to change or customize some of the various features within FE-Sizer.

5.9.1 Flow Units Setup

The *Flow Units Setup* pop-up menu item allows you to modify the flow units drop-down list selections. This feature allows you to customize the flow units for your particular calculation.

5.9.2 User Data

The *User Data pop-up menu* consist of two items to define data pertinent to the user. The menu items are:

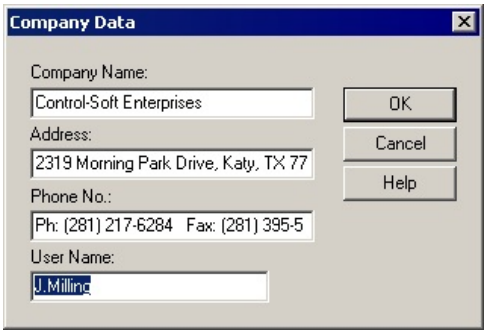


Figure 5-36

Company Data...

This menu item from the Utility/User Data menu activates the *Company Data* dialog shown in Figure 5-36. This dialog consist of four text edit fields to define the company data that will be printed on output files. For this dialog you enter the following information . . .

1. Company Name
2. Address
3. Phone No.
4. User Name

Customer Data...

This menu item from the Utility/User Data menu activates the *Customer Data* dialog shown in Figure 5-37. This dialog consist of five text edit fields that define the customer data to be printed on output files. For this dialog you enter the information for . . .

1. Client
2. Project
3. Location
4. JO/PO No.
   (or job order or purchase order number)
5. Calculation No.

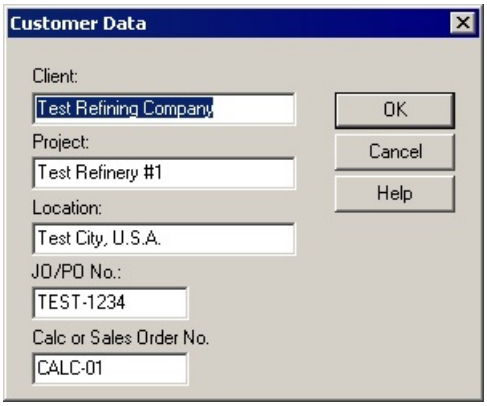


Figure 5-37

5.9.3 Uncertainty...

Uncertainty, otherwise known as accuracy or reproducibility, is defined as "The closeness of agreement between the result of a measurement and the (conventional) true value of the measured." by the International Organization for Legal Metrology (OIML, 1984).

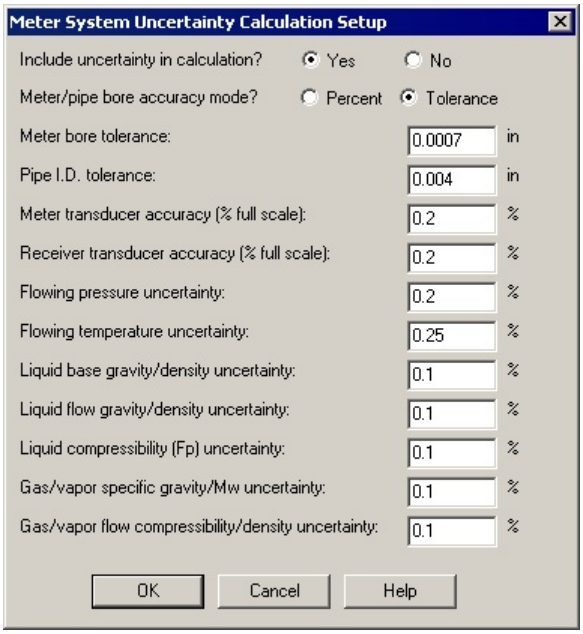


Figure 5-38

Figure 5-38 introduces the dialog input for this menu item where you set the various input values for the uncertainty and tolerance for the many components that make up the overall meter system. These values are used in the uncertainty or accuracy calculation to determine the overall system uncertainty value.

The first set of option buttons switches the uncertainty estimate off and on. When "No" is checked for this value, no uncertainty estimate shall be calculated and the uncertainty portion of the "Calculated Results" screen is turned off. When this option is checked "Yes," FE-Sizer calculates and includes the uncertainty estimate in the screen display. Each input is defined in the following Table.

Table 5-1

Measurement Tolerance & Uncertainty Data Defaults		
ITEM	DESCRIPTION	DEFINITION & VALUES
1	Meter/Pipe bore accuracy mode	Variable to switch the meter bore/pipe accuracy mode from percent of measurement to dimensional tolerance.
2	Meter bore percent accuracy or tolerance	Percent accuracy or fabrication tolerance (depends on Bore/Pipe accuracy mode) for the meter device, e.g., 0.07% or 1/1000th of an inch. Values - 0.0001 to 0.9999 percent, inches, etc.
3	Pipe i.d. percent accuracy or Pipe i.d. tolerance	Percent accuracy or fabrication tolerance (depends on Bore/Pipe accuracy mode) for the pipe, e.g., 0.14% or 1/1000th of an inch. Values - 0.0001 to 0.9999 inches, etc.
4	Meter transducer accuracy	Manufacturers' quoted accuracy for the meter differential pressure transmitter or transducer. Values - 0.0001% to 0.9999%. Valid for all fluids.
5	Receiver transducer accuracy	Manufacturers quoted accuracy for the receiver transducer. Values - 0.0001% to 0.9999%. Valid for all fluids.
6	Flowing pressure uncertainty	Accuracy or uncertainty in the measured flowing pressure. Values - 0.0001% to 0.9999%. Valid only for gas and vapor fluids.
7	Flowing temperature uncertainty	Accuracy or uncertainty in the measured flowing temperature. Values - 0.0001% to 0.9999%. Valid only for gas and vapor fluids.
8	Liquid base gravity/density uncertainty	Accuracy or uncertainty in the measured base specific gravity or density for liquids. Values - 0.0001% to 0.9999%. Valid only for base condition volumetric liquid flows.
9	Liquid flowing gravity/density uncertainty	Accuracy or uncertainty in the measured flowing specific gravity or density for liquids. Values - 0.0001% to 0.9999%. Valid only for flowing condition volumetric liquid flows and all liquid mass flow conditions.
10	Liquid compress (Fp) uncertainty	Accuracy or uncertainty for the given Fp factor for liquid compressibility at the flowing condition pressure. Values - 0.0001% to 0.9999%. Valid only for liquids.
11	Gas/vapor specific gravity or Mw uncertainty	Accuracy or uncertainty for the given gas/vapor specific gravity or molecular weight. Values - 0.0001% to 0.9999%. Valid only for gas and vapor fluids.
12	Gas/vapor flow compress/density uncertainty	Accuracy or uncertainty for the given gas/vapor compressibility/density uncertainty. Values - 0.0001% to 0.9999%. Valid only for gas and vapor fluids.
13	OK	Saves the current uncertainty data to the "fesizer.cfg" configuration file. It is loaded each time the FE-Sizer application is started.
14	Cancel	Cancels the uncertainty data configuration without saving.
15	Help	Displays the help topic for the *Uncertainty Calculation Setup* dialog box.

5.10 Window

The *Window* menu bar item gives the following commands, which enable you to arrange multiple views of documents in the application window:

Cascade

Arranges windows in an overlapped fashion.

Tile
Arranges windows in non-overlapped tiles.

Arrange Icons
Arranges icons of minimized windows.

Window 1, 2, ...
Goes to specified window.

5.11 View

The View menu gives the following commands:

Tool Bar
Shows or hides the toolbar.

Status Bar
Shows or hides the status bar.

5.12 Help

The Help menu gives the following commands to provide you with assistance in using the FE-Sizer application:

FE-Sizer Help Contents
Shows the Help Contents to topics on which you can obtain help.

FE-Sizer Help
Provides general instructions on using help.

About FE-Sizer...
Displays the About Box dialog where you'll find the FE-Sizer version number, release number, license information, free system memory and availaible memory.

6. FE-Sizer TUTORIAL

Sizing orifice flow meters with FE-Sizer is a snap for the experienced as well as the novice engineer. However, it can be somewhat intimidating for the first time user to FE-Sizer. The following tutorial will speed up learning the FE-Sizer user interface.

6.1 Setting Up the Project Database

The first thing you should do to create a new project database is to setup the company and customer data for the project.

➤ **Step 1 - setup the company data:**

4. From the Utility menu, choose User/Company Data. You will see the dialog box for *Company Data* as illustrated in the example of Figure 6-1.

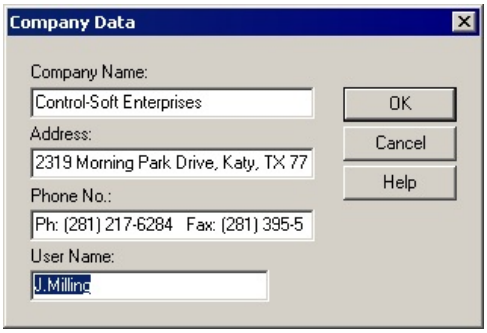


Figure 6-1

5. The *insertion point*, flashing vertical bar, will be already at *Company Name* text edit field. If there is any text defined for the edit box, it will be selected (or highlighted). Enter the text for your company name. FE-Sizer can accept up to 50 characters for the company name.

6. Now move the insertion point to the *Address* field by either pressing the TAB key or by pointing to the *Address* text edit field and clicking the left mouse button. Enter the text for the Address field (maximum 50 characters).

7. Next, select the *Phone No.*: text edit field and enter the phone number (voice or voice/fax) for the company (maximum 50 characters).

8. Lastly, enter the *User Name* for the person sizing the orifices for the project (maximum 25 characters).

➤ **Step 2 - setup the customer data:**

1. From the Utility menu, choose User/Customer Data. You will see the dialog box for *Customer Data* shown in Figure 6-2.

2. Enter or replace the text for the *Client*: text edit box (maximum 30 characters). This is the name for the customer for the project database you are creating.

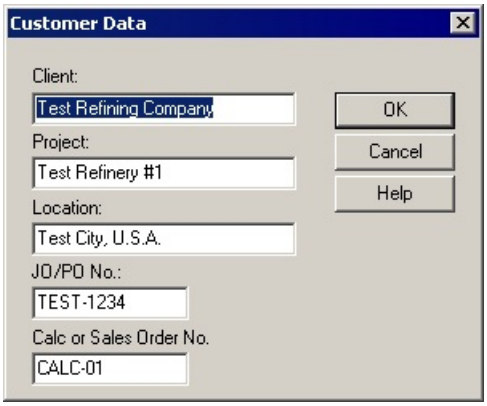


Figure 6-2

3. Enter or replace the text for the *Project*: text edit box (maximum 30 characters). This text should describe the project in enough detail so as to be recognizable by you at some later date.

4. Enter or replace the text for the *Location*: text edit box (maximum 30 characters). This is the location for the project, i.e., city and state or a country.

5. Enter or replace the text for the *JO/PO No.*: text edit box (maximum 15 characters). This is the number assigned by your company to segregate projects from one another.

6. Enter or replace the text for the *Calculation No.*: text edit box (maximum 15 characters). This is usually the number assigned to the flow element sizing package by your company. It can be left blank.

➤ **Step 3 - setup units:**

1. For each variable having units, pulldown the units setting list box to see available units. Slide bar at right of list box allows you to view additional units items for variables that have a lot of selectable units.

2. Double click the desired unit to set units for that variable type. Sometimes units selecting one screen variable affects units for all variables using that same units system.

3. Do this for each variable prior to data entry. All data settings are saved with the calculation and are set for all additional calculations of that fluid and flow unit type.

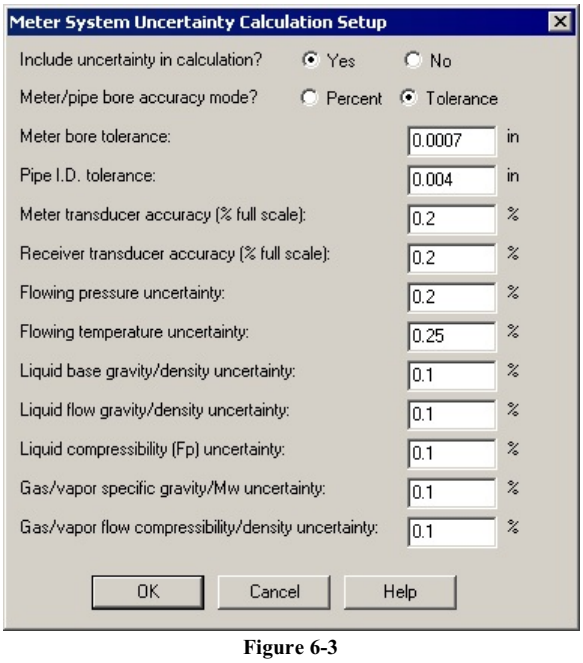


Figure 6-3

➤ **Step 4 - setup the default uncertainty data:**

1. From the Utility menu, choose Uncertainty. You will see the *Uncertainty Calculation Setup* dialog box shown in Figure 6-3.

2. Determine whether to include uncertainty calculations by selecting between the *Yes* and *No* options.

3. Determine whether to define the Meter/Pipe accuracy in *Percent* (0-100%) or *Tolerance* (± 0.01 inches) mode by clicking the appropriate option. Switching between the two modes switches the *Meter bore* and *Pipe I.D.* between percent and tolerance modes.

4. Now, define the default values for the various parameters that define the uncertainty for the meter application. If you do not want to consider effects of the transmitting and receiving instrument on overall uncertainty, enter 0.0 for these inputs. Likewise, if you do not want to consider accuracy of the fluid properties data, you may also enter 0.0 for these inputs as well.

5. Select the **OK** button to save the uncertainty setup in the FE-Sizer configuration file.

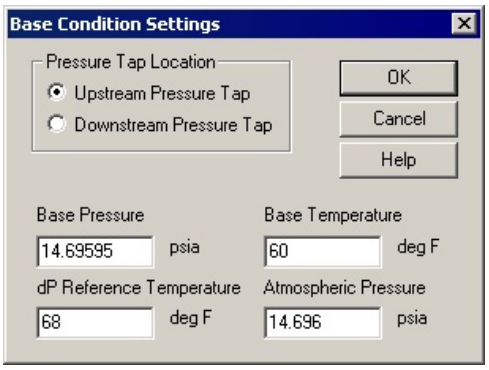


Figure 6-4

➤ **Step 5 - setup the base condition data:**

1. Choose the *Base...* menu item from the menu bar. You will see the *Base Condition Data* dialog illustrated in Figure 6-4.

2. Select the *Pressure Tap Location* option by either clicking on the *Upstream Pressure Tap* or *Downstream Pressure Tap* option. This is the location at which the flowing pressure is to be measured. This value affects the calculated expansion factor for gases and vapors. It has no impact for liquid calculations.

3. Enter the value for the *Base Pressure* numeric edit box in absolute units. Typically this value lies somewhere between 13.0 psia (89.63 kPa-a) and 15.0 psia (103.42 kPa-a).

4. Enter the value for the *Base Temperature* numeric edit box. Typically, this value is 60 °F (15.56 °C). However, note that for ISO "Normal" conditions, the base temperature is 0 °C.

5. Enter the *dP Reference Temperature*. This is the reference temperature for the differential pressure measurement standard, i.e., 68 °F (20 °C) for ASME and ISO standards, 60 °F (15.56 °C) for AGA/ANSI standards.

6. The value for *Atmospheric Pressure* was already defined in the previous units configuration. However, you can set the value in this dialog to overwrite the previous settings for the project database. However, the next time you start FE-Sizer the previous value shall appear as the default until you open this project. Opening the project will overwrite any previous value with the value for the project database.

   Select the **OK** button exit the *Base Condition Data* dialog.

➤ **Step 6 - create the project database:**

1. Choose the *New Project* command from the *Files/P*roject menu. You are presented the *New Project File* dialog shown in Figure 6-5. Enter the required "File name" and click the **Save** button. Otherwise, you can select the **Cancel** button and correct the data using the appropriate step above.

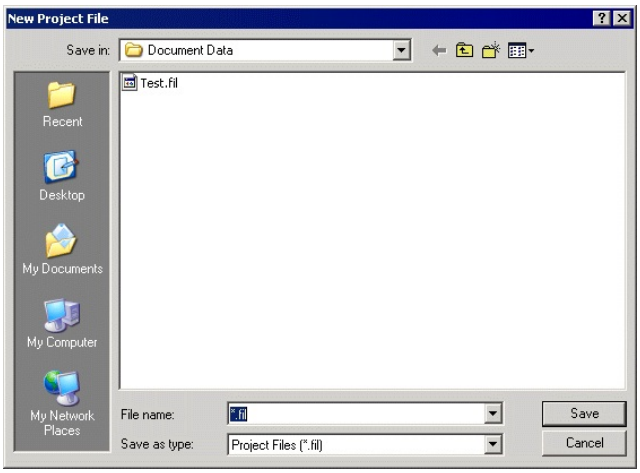


Figure 6-5

2. Once you select the **OK** button, you see the *Customer Data* dialog illustrated in the following Figure 6-6. Enter the required information to define the client and project. Once done, select the **OK** button to save the project database files. You should have now successfully created a project database from which you can add and delete project calculations.

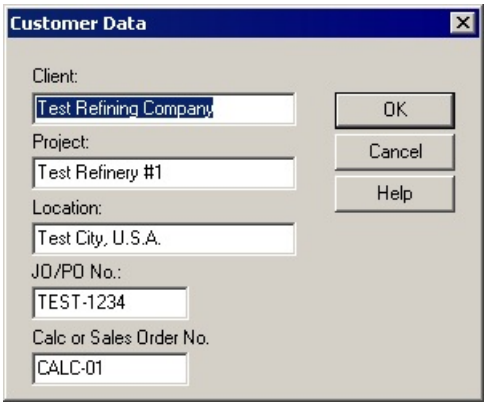


Figure 6-6

6.2 Calculating the Sizing Parameter

➤ **Step 1 - set the required sizing parameter:**

1. Choose *Calculation Setup* from the *Sizing* menu or choose the graphic icon for the calculation setup from the tool bar. You are presented with the *Calculation* Setup dialog of Figure 6-7.

2. Select the *Sizing Parameter* by either selecting the *Calculate for Bore*, *Calulate for dP*, or *Calculate for Flow* option. The bore sizing parameter calculates the meter bore, the dP parameter calculates the meter differential, and the flow parameter calculates the flow across the meter.

3. Next, select the calculation mode from the *Calculation Mode* options group. For this item you can select between *Flow Meter Sizing*, Critical Drop Restriction Sizing, or *Pressure Drop Restriction Sizing*. The flow meter sizing option is for basic flow meter application sizing. The critical drop restriction sizing is for sizing critical drop

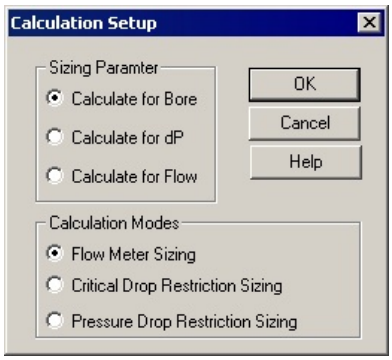


Figure 6-7

flow restriction devices which limit the flow across the orifice regardless of pressure variances in the downstream pressure that do not exceed the application tolerances. The pressure drop restriction sizing sizes devices for delivering a permanent pressure drop loss for the given flow and pressure conditions.

4. Select the **OK** button once the calculation setup is complete.

➤ **Step 2 - enter the tag information:**

1. Enter the information for the *Tag No.:* found to the left and immediately below the tool bar. You can use the *Input Sizing Data* option from the *Sizing* menu to immediately set the insertion point to this item. The tag number will be the key index from which you will save and retrieve calculation records. Therefore, it must be unique.

2. Now enter the *Service Description* found to the immediate right of the *Tag No.*: item. You can either press the TAB key or use the mouse to set focus to this item.

3. Lastly, set the *Line No.*: item immediately to the right of the *Service Description*.

➤ **Step 3 - select the meter data:**

1. Set the meter data by selecting the meter type from the *Meter Data* pop-up menu from the *Meter/Pipe* menu. Additionally, you can quickly select a meter type by pressing its graphic icon from the tool bar. Figure 6-8 shows an example for the *Orifice Plate Data* dialog which is used to illustrate this step.

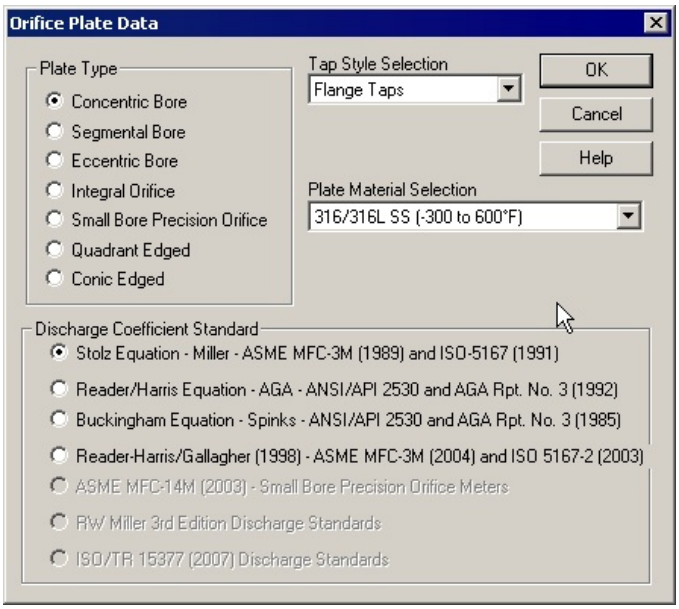

Orifice Plate Data
Plate Type
Concentric Bore
Segmental Bore
Eccentric Bore
Integral Orifice
Small Bore Precision Orifice
Quadrant Edged
Conic Edged
Tap Style Selection
Flange Taps
OK
Cancel
Help
Plate Material Selection
316/316L SS (-300 to 600°F)
Discharge Coefficient Standard
Stolz Equation - Miller - ASME MFC-3M (1989) and ISO-5167 (1991)
Reader/Harris Equation - AGA - ANSI/API 2530 and AGA Rpt. No. 3 (1992)
Buckingham Equation - Spinks - ANSI/API 2530 and AGA Rpt. No. 3 (1985)
Reader-Harris/Gallagher (1998) - ASME MFC-3M (2004) and ISO 5167-2 (2003)
ASME MFC-14M (2003) - Small Bore Precision Orifice Meters
RW Miller 3rd Edition Discharge Standards
ISO/TR 15377 (2007) Discharge Standards

Figure 6-8

2. Select the plate type from the options grouped under *Plate Type*. The available choices are *Concentric Bore*, *Segmental Bore*, *Eccentric Bore*, etc.

3. Select the tap style from the *Tap Style Selection* drop down list selection box.

4. Select the plate material from the *Plate Material Selection* drop down list selection box.

5. Check the appropriate discharge coefficient standard from the *Discharge Coefficient Standard* grouping.

6. Press the **OK** button to finalize your selections and return to the *sizing screen*.

➤ **Step 4 - select the pipe data:**

1. Setup the piping data by selecting the *Pipe Data* from the *Meter/Pipe* menu or by pressing its graphic icon from the tool bar. Figure 6-9 shows an example for the *Pipe Data* dialog.

2. Enter the value for the *Pipe Nominal Diameter* numeric edit box.

3. Select the pipe schedule from the *Pipe Schedule* drop down list box.

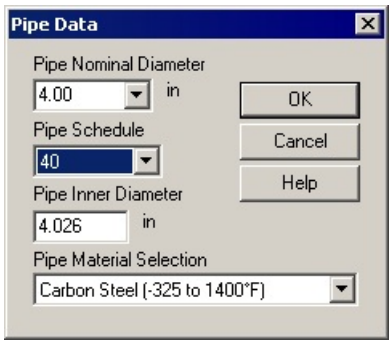


Figure 6-9

4. The appropriate pipe I.D. should automatically appear in the *Pipe Inner Diameter* numeric edit box. Override this value only if necessary.

5. Select the pipe material from the *Pipe Material Selection* drop down list selection box.

6. Press the **OK** button to finalize your selections and return to the *sizing screen*.

➤ **Step 5 - set the fluid type and enter the properties:**

1. Pull down the *Fluids* menu and select the appropriate fluid for the application. Available options are shown in Figure 6-10. Note that you can select the *Calc Fluid Properties* item to use one of the included properties correlations to automatically enter the data for this screen section. Refer to Section 9 for details regarding the fluid property correlations.

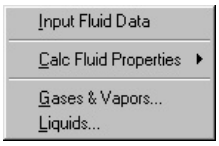


Figure 6-10

2. Once you've set the type fluid, go to the *Input Fluid Data* item of the *Fluids* menu or use the graphic icon counterpart from the tool bar if you elect to manually set the fluid property data. Note that this screen area will change to the defined fluid properties for the chosen fluid.

➤ **Step 6 - enter the sizing data:**

Enter the required sizing data for your application in the *Sizing Data* screen. See the example screen section shown in Figure 6-11. Note that this area changes depending on the sizing parameter selection and calculation mode set for FE-Sizer.

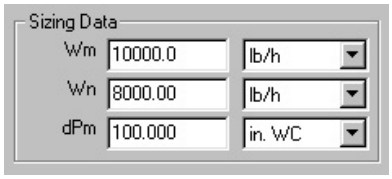


Figure 6-11

➤ **Step 7 - select any appropriate factors:**

Set any necessary factors via the *Factors* item from the menu bar illustrated in Figure 6-12. Refer to Section 5 for specific details on the use of correction factors in FE-Sizer.

Figure 6-12

➤ **Step 8 - calculate the sizing parameter:**

You can calculate the sizing parameter any one of three ways. They are:

1. Click on the *Calculate* button at the lower right of the *sizing screen*.

2. Pull down the *Sizing Menu* from the *Menu Bar* and select the *Calculate Sizing Parameter* item.

3. Click on the *Calculator* icon on the *Tool Bar*.

If all the data was entered correctly, the sizing parameter should be calculated and the results displayed in the *Calculation Screen* on the right side of the *sizing screen* for FE-Sizer.

7. DATA SHEET ENTRY

7.1 Datasheet Entry - Part 1 of 3

When you select the *File/ Datasheet/ Datasheet Entry* menu option, or the Datasheet graphic icon from the Tool Bar, FE-Sizer activates the *Datasheet En*try - Part 1 of 3 dialog illustrated in Figure 7-1. There are three dialogs for data sheet entry required to completely define a flow meter application. To the left of the dialog are six menu buttons defined in the sections that follow.

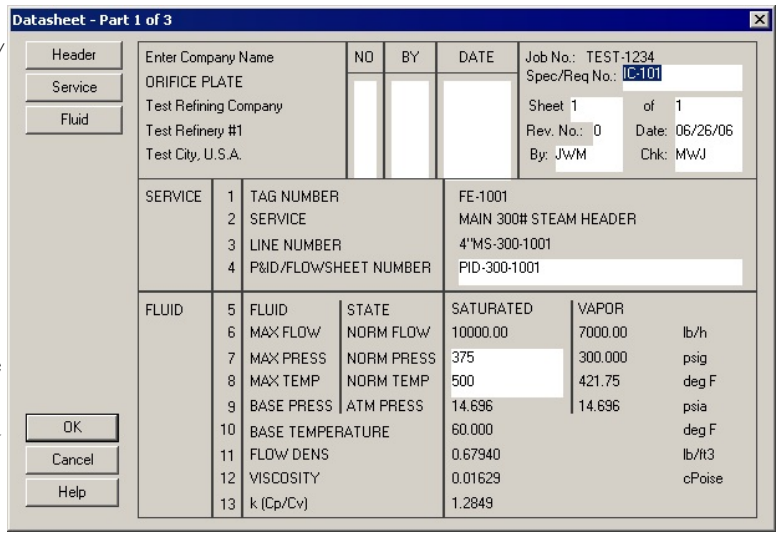


Figure 7-1

Header

The *Header* button command moves the input focus to the first item of the *header* section found at the top of the data sheet shown in Figure 7-1. Enabled data inputs are highlighted. You can move to the next input box by pressing the TAB key or by selecting with the mouse.

Service

The *Service* button moves input focus to the **SERVICE** section of the data sheet. There is only one item for input which is the P&ID/Flowsheet Number. This input is shown on Line Item 4 of the data sheet illustrated in Figure 7-1.

Fluid

The *Fluid* button moves the input focus to the **FLUID** section of the data sheet. These items specify the Max Press and Max Temp values shown on Line Items 7 and 8.

OK

Enters all the changed data for the data sheet and returns to the *Calculation Screen*.

Cancel

Cancels all changes to the data sheet and returns to the *Calculation Screen*.

Help

Activates the help topic for the Part 1 Data Entry Dialog screen.

7.2 Datasheet Entry - Part 2 of 3

Figure 7-2 shows an example of the *Datasheet Entry - Part 2 of 3* dialog box for continuing the data sheet data entry. This dialog is activated by the *Part 2 Data* menu button of the previous dialog box. Also, for this dialog there are a row of menu buttons on the left side of the dialog box. Their functions are . . .

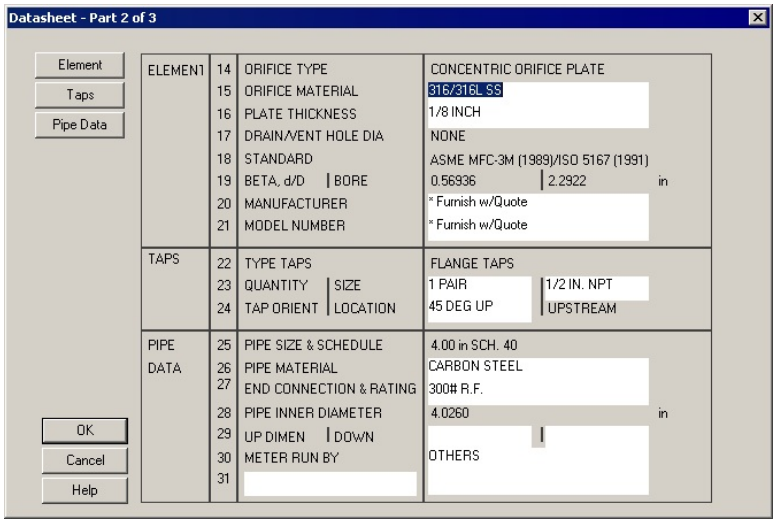


Figure 7-2

Element

The *Element* menu button jumps input focus to the first input field for the **ELEMENT** section of the data sheet. This section is used to define the orifice or meter type, material, plate thickness, etc. Line Items 15, 16, 20 and 21 of the data sheet define this section as illustrated by the example screen of Figure 7-2.

Taps

The *Taps* menu button jumps input focus to the first input for the **TAP** section of the data sheet. This section defines the tap quantity, tap size and tap orientation covered by Line Items 22 through 24 of the data sheet.

Pipe

The *Pipe* menu button jumps input focus to the first input for the **PIPE** section of the data sheet. This section gives the pipe material, end connection and rating, upstream and downstream dimensions for meter runs, meter run furnished by, and an a user-defined optional line. They are covered by Line Items 26, 27, 29 30 and 31 of the data sheet.

OK

Enters all the changed data for the data sheet and returns to the *Calculation Screen*.

Cancel

Cancels all changes to the data sheet and returns to the *Calculation Screen*.

Help

Activates the help topic for the Part 2 Data Entry Dialog screen.

7.3 Datasheet Entry - Part 3 of 3

An example of the *Datasheet Entry - Part 3 of 3* dialog box for the final data entry dialog is shown in Figure 7-3. This dialog is activated by the *Part 3 Data* menu button of the previous dialog box. As in the previous dialogs, there are a row of menu buttons on the left side of the dialog box. Their functions are . . .

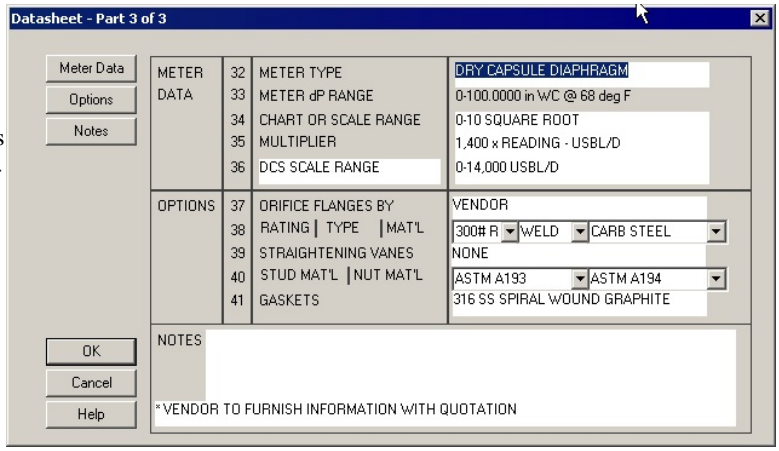


Figure 7-3

Meter Data

The *Meter* menu button activates the input fields for the **METER** section of the data sheet. These items specify the meter type, chart or scale range, multiplier and a user-defined optional line covered by Line Items 32, 34, 35 and 36 of the data sheet.

Options

The *Options* menu button set the current input focus to first item for the **OPTIONS** section. The items for this section vary depending on the selected meter type. For orifice plates, as illustrated in Figure 7-3, the available items for input are orifice flanges supplied by, flange rating, flange type, flange material, straightening vanes, stud material, bolt material, and gasket information. This section covers Line Items 37 through 41 of the data sheet. For other meter types than orifice inputs for orifice flanges and material are omitted and two user-defined optional lines are added at the bottom of this section.

Notes

The *Notes* menu button activates the first input field of the **NOTES** section. These are user-defined notes that further specify any special requirements you may have. The very last note input is offset from the first three so as to allow any general note that may be common to all data sheets.

OK

Enters all the changed data for the data sheet and returns to the *Calculation Screen*.

Cancel

Cancels all changes to the data sheet and returns to the *Calculation Screen*.

Help

Activates the help topic for the Part 3 Data Entry Dialog screen.

8. DATA IMPORTING AND EXPORTING

FE-Sizer's import/export function allows you to interface FE-Sizer project databases with other software applications and external databases. It enables you to take advantage of FE-Sizer's powerful *batch* command feature for batch calculations. FE-Sizer uses the standard ASCII delimited text file format to interface external database files with project databases. This allows direct imports of the FE-Sizer ASCII data file into database applications, such as, Microsoft's Access®, etc. Table 8-1 describes each column of data as it pertains to data within FE-Sizer.

Table 8-1

COL #	SYMBOL	VARIABLE DESCRIPTION	DESCRIPTOR
1	N/A	Tag Number	[S01]
2	N/A	Service Description	[S02]
3	N/A	Line Number	[S03]
4	N/A	File Date	[S04]
5	N/A	Prepared By	[S05]
6	N/A	Calc Memo	[S06]
7	N/A	Fluid Type	[S07]
8	N/A	Meter Type Description	[S08]
9	N/A	Meter Style	[S09]
10	N/A	Tap Style	[S10]
11	N/A	Element Material	[S11]
12	N/A	Pipe Material	[S12]
13	N/A	Pipe Schedule	[S13]
14	N/A	Manufacturer	[S14]
15	N/A	Model Number	[S15]
16	N/A	Spec No	[S16]
17	N/A	Spec Rev No	[S17]
18	N/A	Spec By (Initials)	[S18]
19	N/A	Spec Chk (Initials)	[S19]
20	N/A	Spec Date	[S20]
21	N/A	Rev Row 1	[S21]
22	N/A	Rev Row 2	[S22]
23	N/A	Rev Row 3	[S23]
24	N/A	Rev Row 4	[S24]
25	N/A	Rev By Row 1	[S25]
26	N/A	Rev By Row 2	[S26]
27	N/A	Rev By Row 3	[S27]

Table 8-1			
COL #	SYMBOL	VARIABLE DESCRIPTION	DESCRIPTOR
28	N/A	Rev By Row 4	[S28]
29	N/A	Rev Date Row 1	[S29]
30	N/A	Rev Date Row 2	[S30]
31	N/A	Rev Date Row 3	[S31]
32	N/A	Rev Date Row 4	[S32]
33	N/A	Sht No	[S33]
34	N/A	Sht Of	[S34]
35	N/A	P&ID No	[S35]
36	N/A	Element Bore Material	[S36]
37	N/A	Element Body Material	[S37]
38	N/A	Element Thickness	[S38]
39	N/A	Element Construction	[S39]
40	N/A	Element End Connection	[S40]
41	N/A	Tap Quantity	[S41]
42	N/A	Tap Size	[S42]
43	N/A	Tap Orientation	[S43]
44	N/A	Pipe Material	[S44]
45	N/A	Pipe End Connection & Rating	[S45]
46	N/A	Upstream Straight Pipe	[S46]
47	N/A	Downstream Straight Pipe	[S47]
48	N/A	Meter Run By	[S48]
49	N/A	Meter Type	[S49]
50	N/A	Meter Chart Scale	[S50]
51	N/A	Meter Multiplier	[S51]
52	N/A	Orifice Flanges By	[S52]
53	N/A	Flange Rating	[S53]
54	N/A	Flange Type	[S54]
55	N/A	Flange Material	[S55]
56	N/A	Straightening Vanes	[S56]
57	N/A	Stud Material	[S57]
58	N/A	Nut Material	[S58]
59	N/A	Gasket Type	[S59]
60	N/A	User Input Line 1 Part 1	[S60]
61	N/A	User Input Line 1 Part 2	[S61]

Table 8-1			
COL #	**SYMBOL**	**VARIABLE DESCRIPTION**	**DESCRIPTOR**
62	N/A	User Input Line 2 Part 1	[S62]
63	N/A	User Input Line 2 Part 2	[S63]
64	N/A	User Input Line 3 Part 1	[S64]
65	N/A	User Input Line 3 Part 2	[S65]
66	N/A	User Input Line 4 Part 1	[S66]
67	N/A	User Input Line 4 Part 2	[S67]
68	N/A	User Input Line 5 Part 1	[S68]
69	N/A	User Input Line 5 Part 2	[S69]
70	N/A	User Notes Line 1	[S70]
71	N/A	User Notes Line 2	[S71]
72	N/A	User Notes Line 3	[S72]
73	N/A	User Notes Line 4	[S73]
74	N/A	Flow Units Setting	[I01]
75	N/A	Pressure Units Setting	[I02]
76	N/A	Base Pressure Units Setting	[I03]
77	N/A	Atm Pressure Units Setting	[I04]
78	N/A	Meter dP Units Setting	[I05]
79	N/A	Temperature Units Setting	[I06]
80	N/A	Base Temperature Units Setting	[I07]
90	N/A	dPRef Temperature Units Setting	[I08]
91	N/A	Density Units Setting	[I09]
92	N/A	Viscosity Units Setting	[I10]
93	N/A	Velocity Units Setting	[I11]
94	N/A	Local Gravity Units Setting	[I12]
95	N/A	Bore Units Setting	[I13]
96	N/A	Pipe Nom Diameter Units Setting	[I14]
97	N/A	Gage or Abs Pressure Setting	[I15]
98	N/A	Fluid Equation	[I16]
99	N/A	Fluid Condition	[I17]
100	N/A	Fluid Property	[I18]
101	N/A	Manometer Factor	[I19]
102	N/A	Drain/Vent Factor	[I20]
103	N/A	Drain/Vent Selection Setup	[I21]
104	N/A	Drain/Vent Selection	[I22]

Table 8-1			
COL #	**SYMBOL**	**VARIABLE DESCRIPTION**	**DESCRIPTOR**
105	N/A	Water Vapor Factor Setup	[I23]
106	N/A	Water Vapor Include Flag	[I24]
107	N/A	Sat Liquid Correction Factor	[I25]
108	N/A	Vapor Quality Factor	[I26]
109	N/A	Meter Type	[I27]
110	N/A	Meter Style	[I28]
111	N/A	Venturi Exit Cone Style	[I29]
112	N/A	IFOA Manufacturer Selection	[I30]
113	N/A	IFOA Size	[I31]
114	N/A	IFOA Pipe Material	[I32]
115	N/A	Tap Style	[I33]
116	N/A	Tap Location	[I34]
117	N/A	Pipe Material	[I35]
118	N/A	Element Material	[I36]
119	N/A	Pipe Schedule	[I37]
120	N/A	Calculation Mode	[I38]
121	N/A	Discharge Coefficient Standard	[I39]
122	N/A	Calculation Sizing Parameter	[I40]
123	N/A	Calculation Revision	[I41]
124	N/A	Flow Conversion Factor	[D01]
125	N/A	Pressure Conversion Factor	[D02]
126	N/A	Base Press Conversion Factor	[D03]
127	N/A	Atm Press Conversion Factor	[D04]
128	N/A	Diff Press Conversion Factor	[D05]
129	N/A	Density Conversion Factor	[D06]
130	N/A	Viscosity Conversion Factor	[D07]
131	N/A	Velocity Conversion Factor	[D08]
132	N/A	Local Gravity Conversion Factor	[D09]
133	N/A	Bore Conversion Factor	[D10]
134	N/A	Nom Pipe Dia Conversion Factor	[D11]
135	Q_m q_m W_m	Maximum Flow	[D12] [D12] [D12]

Table 8-1			
COL #	**SYMBOL**	**VARIABLE DESCRIPTION**	**DESCRIPTOR**
136	Q_n q_n W_n	Normal Flow	[D13] [D13] [D13]
137	P_f	Flowing Pressure	[D14]
138	T_f	Flowing Temperature	[D15]
139	D_f G_f Z_f	Flowing Density Flowing Specific Gravity Flowing Compressibility	[D16] [D16] [D16]
140	P_b	Base Pressure	[D17]
141	T_b	Base Temp	[D18]
142	G_b D_b Z_b	Base Specific Gravity Base Density Base Compressibility	[D19] [D19] [D19]
143	dP_m	Maximum Differential	[D20]
144	dP_n	Normal Differential	[D21]
145	dP LOSS%	Permanent Pressure Loss Percent	[D22]
146	F_{ad}	Meter Expansion Factor	[D23]
147	F_{aD}	Pipe Expansion Factor	[D24]
148	N/A	Seal Fluid Density	[D25]
149	N/A	Seal Fluid Temperature	[D26]
150	G_L	Local Acceleration Due to Gravity	[D27]
151	d_{DH}	Diameter of Drain/Vent Hole	[D28]
152	N/A	Water Vapor Pressure	[D29]
153	P_V	Absolute Water Vapor Pressure	[D30]
154	X	Quality or Mass Percent	[D31]
155	D_{TP}	Steam Quality Density	[D32]
156	N/A	Nominal Pipe Diameter	[D33]
157	D	Inner Pipe Diameter	[D34]
158	U	Viscosity	[D35]
159	k F_P	Specific Heat Ratio Liquid Compress	[D36] [D36]
160	M_w D_{fl} P_v	Gas Molecular Weight Gas Density Liquid Vapor Pressure	[D37] [D37] [D37]
161	N/A	Beta Calculation @ Percent Range	[D38]
162	F_{DH}	Drain Vent/Hole Factor	[D39]
163	$F_{WV,dry}$	Water Vapor Factor	[D40]

Table 8-1			
COL #	**SYMBOL**	**VARIABLE DESCRIPTION**	**DESCRIPTOR**
164	F_X	Quality Factor	[D41]
165	F_m	Manometer Correction Factor	[D42]
166	S_m	Meter Sizing Factor	[D43]
167	R_D	Reynolds Number @ Normal Flow	[D44]
168	Y	Gas Expansion Factor	[D45]
169	C	Calculated Discharge Coefficient	[D46]
170	r K_0	Radius of Quadrant Flow Coef Incl Approach Factor	[D47] [D47]
171	K	Specific Heat Ratio	[D48]
172	E F_{TP}	Velocity of Approach Factor Static to Total Pressure Factor	[D49] [D49]
173	ß	Calculated Beta	[D50]
174	d	Calculated Bore	[D51]
175	H_S	Height of Segment	[D52]
176	D_C	Diameter of Segment	[D53]
177	N/A	D/p Reference Temperature	[D54]
178	N/A	D/p Reference Temp Correction	[D55]
179	P_{atm}	Atmospheric Pressure	[D56]
180	N/A	Meter Uncertainty	[D57]
181	N/A	System Uncertainty	[D58]
182	N/A	Throat Velocity	[D59]
183	N/A	Minimum Plate Thickness	[D60]
184	N/A	Max Pressure	[D61]
185	N/A	Max Temperature	[D62]

The following defines the descriptor given in the last column of Table 8-1 to assist you in identifying the data imported and/or exported.

[S01] = String input for tag number entry (18 characters maximum).
[S02] = String input for service description (50 characters maximum).
[S03] = String input for line number or designation (25 characters maximum).
[S04] = String input for file date (14 characters maximum).
[S05] = String input for calc prepared by name (25 characters maximum).
[S06] = String input for calculation memo (100 characters maximum).
[S07] = String input for fluid description (34 characters maximum).
[S08] = String input for meter type description (24 characters maximum).
[S09] = String input for meter style description (34 characters maximum).
[S10] = String input for tap type description (24 characters maximum).

[S13]	=	String input for pipe schedule description (7 characters maximum). Defined inputs that will automatically determine the inside pipe are: 10, 20, 30, 40, 60, 80, 100, 120, 140, 160, STD, XS, and XXS. The nominal pipe diameter must be specified in order to automatically determine inside diameter of pipe. All other inputs for pipe schedule require inside pipe diameter to be specified.
[S14]	=	Orifice device manufacturer - from spec datasheet portion (30 characters maximum).
[S15]	=	Orifice device model number - from spec datasheet portion (30 characters maximum).
[S16]	=	Spec datasheet number (11 characters maximum).
[S17]	=	Spec datasheet revision number (2 characters maximum).
[S18]	=	Spec datasheet by (initials 3 characters maximum).
[S19]	=	Spec datasheet checked by (initials 3 characters maximum).
[S20]	=	Spec datasheet date prepared (8 characters maximum).
[S21]	=	Spec datasheet rev block revision row 1 (2 characters maximum).
[S22]	=	Spec datasheet rev block revision row 2 (2 characters maximum).
[S23]	=	Spec datasheet rev block revision row 3 (2 characters maximum).
[S24]	=	Spec datasheet rev block revision row 4 (2 characters maximum).
[S25]	=	Spec datasheet rev block rev by row 1 (initials 3 characters maximum).
[S26]	=	Spec datasheet rev block rev by row 2 (initials 3 characters maximum).
[S27]	=	Spec datasheet rev block rev by row 3 (initials 3 characters maximum).
[S28]	=	Spec datasheet rev block rev by row 4 (initials 3 characters maximum).
[S29]	=	Spec datasheet rev block rev date row 1 (8 characters maximum).
[S30]	=	Spec datasheet rev block rev date row 2 (8 characters maximum).
[S31]	=	Spec datasheet rev block rev date row 3 (8 characters maximum).
[S32]	=	Spec datasheet rev block rev date row 4 (8 characters maximum).
[S33]	=	Spec datasheet sheet number (4 characters maximum).
[S34]	=	Spec datasheet sheet of (4 characters maximum).
[S35]	=	P&ID number (15 characters maximum).
[S36]	=	Element bore material (30 characters maximum).
[S37]	=	Element body material (30 characters maximum).
[S38]	=	Element thickness (30 characters maximum).
[S39]	=	Element construction (30 characters maximum).
[S40]	=	Element end connection (30 characters maximum).
[S41]	=	Tap quantity (15 characters maximum).
[S42]	=	Tap size (15 characters maximum).
[S43]	=	Tap orientation (15 characters maximum).
[S44]	=	Pipe material (30 characters maximum).
[S45]	=	Pipe end connection & rating (30 characters maximum).
[S46]	=	Upstream straight pipe required (16 characters maximum).
[S47]	=	Downstream straight pipe required (16 characters maximum).
[S48]	=	Meter run by (30 characters maximum).
[S49]	=	Meter type (30 characters maximum).
[S50]	=	Meter chart scale (30 characters maximum).
[S51]	=	Meter multiplier (30 characters maximum).
[S52]	=	Orifice flange by (30 characters maximum).
[S53]	=	Flange rating (10 characters maximum).
[S54]	=	Flange type (10 characters maximum).
[S55]	=	Flange material (10 characters maximum).
[S56]	=	Straightening vanes (30 characters maximum).

[S57] = Stud material (15 characters maximum).
[S58] = Nut material (15 characters maximum).
[S59] = Gasket type (30 characters maximum).
[S60] = User input line 1 part 1 (30 characters maximum).
[S61] = User input line 1 part 2 (30 characters maximum).
[S62] = User input line 2 part 1 (30 characters maximum).
[S63] = User input line 2 part 2 (30 characters maximum).
[S64] = User input line 3 part 1 (30 characters maximum).
[S65] = User input line 3 part 2 (30 characters maximum).
[S66] = User input line 4 part 1 (30 characters maximum).
[S67] = User input line 4 part 2 (30 characters maximum).
[S68] = User input line 5 part 1 (30 characters maximum).
[S69] = User input line 5 part 2 (30 characters maximum).
[S70] = User notes line 1 (63 characters maximum).
[S71] = User notes line 2 (63 characters maximum).
[S72] = User notes line 3 (63 characters maximum).
[S73] = Extended user notes (69 characters maximum).

[I01] = Integer value to determine the flow units selection as follows:

INTEGER	FLOW UNIT SETTING		
	gas	gas/liq	liquid
0	scfd	lb/d	USBBL/d
1	scfh	lb/h	USBBL/h
2	scfm	lb/m	USGpd
3	scfs	lb/s	USGph
4	Nm3/d	kg/d	USGps
5	Nm3/h	kg/h	IMPGpd
6	Nm3/m	kg/m	IMPGph
7	Nm3/s	kg/s	IMPGpd
8	Sm3/d	tons/d	M3/d
9	Sm3/h	tons/h	M3/h
10	Sm3/m	ton-m/d	L/h
11	Sm3/s	ton-m/h	L/m

[I02] = Integer value to determine the pressure units selection as follows:

INTEGER	PRESSURE UNIT SETTING
0	psig
1	psia
2	kPa-ga
3	kPa-ab
4	MPa-ga
5	MPa-ab
6	bar-ga
7	bar-ab
8	mbar-ga
9	mbar-ab
10	kg/cm2-ga
11	kg/cm2-ab

[I03] = Integer value to determine the base pressure units selection as follows:

INTEGER	PRESSURE UNIT SETTING
0	psia
1	kPa-ab
2	MPa-ab
3	bar-ab
4	mbar-ab
5	kg/cm2-ab

[I04] = Integer value to determine the atmospheric pressure units selection as follows:

INTEGER	PRESSURE UNIT SETTING
0	psia
1	kPa-ab
2	MPa-ab
3	bar-ab
4	mbar-ab
5	kg/cm2-ab

[I05] = Integer value to determine the meter dP units selection as follows:

INTEGER	PRESSURE UNIT SETTING
0	in. WC
1	ft. WC
2	mm WC
3	in. Hg (60°F)
4	in. Hg (0°C)
5	psid
6	Pa-d
7	kPa-d
8	Mpa-d
9	bar-d
10	mbar-d
11	kg/cm2-d

[I06] = Integer value to determine the temperature units selection as follows:

INTEGER	TEMPERATURE UNIT SETTING
0	deg F
1	deg R
2	deg C
3	deg K

[I07] = Integer value to determine the base temperature units selection as follows:

INTEGER	TEMPERATURE UNIT SETTING
0	deg F
1	deg R
2	deg C
3	deg K

[I08] = Integer value to determine the dP reference temperature units selection as follows:

INTEGER	TEMPERATURE UNIT SETTING
0	deg F
1	deg R
2	deg C
3	deg K

[I09] = Integer value to determine the density units selection as follows:

INTEGER	DENSITY UNIT SETTING
0	lb/ft3
1	kg/cm3
2	kg/m3
3	g/cm3
4	g/m3
5	oz-av/in3
6	slug/ft3
7	lb/gal-US
8	lb/gal-UK
9	oz-av/gal-US
10	oz-av/gal-UK
11	grain/gal

[I10] = Integer value to determine the viscosity units setting as follows:

INTEGER	VISCOSITY UNIT SETTING
0	cPoise
1	Poise
2	mPa-s
3	Pa-s
4	lb-s/ft2
5	lb-s/in2
6	lbm/ft2-s
7	lbm/in2-s
8	gmf-s/cm2
9	g-cm/s
10	dyne-s/cm2
11	N-s/cm2

[I11] = Integer value to determine the velocity units setting as follows:

INTEGER	VELOCITY UNIT SETTING
0	ft/s
1	m/s
2	mph
3	kph

[I12] = Integer value to determine the local gravity units setting as follow:

INTEGER	LOCAL GRAVITY UNIT SETTING
0	ft/s^2
1	m/s^2

[I13] = Integer value to determine the bore units setting as follows:

INTEGER	BORE UNIT SETTING
0	in.
1	mm
2	cm

[I14] = Integer value to determine the nominal pipe diameter units setting as follows:

INTEGER	BORE UNIT SETTING
0	in.
1	mm
2	cm

[I15] = Integer value to indicate the pressure system as follows:

INTEGER	PRESSURE SYSTEM SETTING
0	gage
1	absolute

[I16] = Integer value to determine the fluid equation as follows:

INTEGER	FLUID EQUATION
1345	Liquid Volumetric Flow Equation
1346	Liquid Mass Flow Equation
1352	Gas or Vapor Volumetric Flow Equation
1353	Gas or Vapor Mass Flow Equation

[I17] = Integer value to determine the fluid equation condition as follows:

INTEGER	FLUID EQUATION CONDITION
1347	Liquid Base Conditions
1348	Liquid Flowing Conditions
1354	Gas or Vapor Base Conditions
1355	Gas or Vapor Flowing (Actual) Conditions

[I18] = Integer value to determine the fluid property as follows:

INTEGER	FLUID PROPERTY
1349	Liquid Specific Gravity
1350	Liquid Density
1356	Gas or Vapor Specific Gravity
1357	Gas or Vapor Molecular Weight
1358	Gas or Vapor Density

[I19] = Integer value to determine manometer factor setting:

INTEGER	MANOMETER FACTOR SETTING
0	Off
1	On

[I20] = Integer value to determine drain or vent factor setting:

INTEGER	DRAIN/VENT FACTOR SETTING
0	Off
1	On

[I21] = Integer value to determine drain or vent factor setup:

INTEGER	DRAIN/VENT DIAMETER INPUT TYPE
1187	From List
1190	Manual

[I22] = Integer value to determine drain or vent hole selection from list:

INTEGER	DRAIN/VENT DIAMETER
1	3/31 in. (2.38 mm)
2	1/8 in. (3.38 mm)
3	5/32 in. (3.96 mm)
4	3/16 in. (4.76 mm)
5	7/32 in. (5.56 mm)
6	1/4 in. (6.35 mm)
7	9/32 in. (7.14 mm)
8	5/16 in. (7.84 mm)
9	11/32 in. (8.73 mm)
10	3/8 in. (9.53 mm)
11	13/32 in. (10.32 mm)
12	7/16 in. (11.11 mm)
13	15/32 in. (11.91 mm)
14	1/2 in. (12.70 mm)

[I23] = Integer value to determine water vapor pressure input setting:

INTEGER	WATER VAPOR PRESSURE SETTING
1211	calculated from flowing temperature
1212	calculated from user determined temperature
1213	calculated from relative humidity input

[I24] = Integer value to determine water vapor correction setting:

INTEGER	WATER VAPOR CORRECTION
0	Off
1	On

[I25] = Integer value to determine saturated liquid correction factor setting:

INTEGER	SATURATED LIQUID CORRECTION
0	Off
1	On

[I26] = Integer value to determine vapor quality correction factor setting:

INTEGER	VAPOR QUALITY CORRECTION
0	Off
1	On

[I27] = Integer value to determine selected meter type as follows:

INTEGER	METER TYPE
1128	Concentric Bore Orifice Plate
1129	Segmental Orifice Plate
1130	Eccentric Orifice Plate
1131	Quadrant Entrance Orifice Plate
1132	Small Bore Honed Meter Run Assembly
1133	Integral Orifice Assembly
1134	Conic Entrance Orifice Plate
1150	ASME Radius Flow Nozzle
1151	ASME Throat Tap Nozzle
1152	ISA Flow Nozzle
1153	Venturi Nozzle (ISA Inlet)
1156	Venturi Machined Inlet
1157	Venturi Rough Cast Inlet
1158	Venturi Rough Welded Sheet Iron Inlet
1163	Universal Venturi Tube (UVT)
1165	Lo Loss Flow Tube
1360	Custom Meter Input - Orifice Plate
1361	Custom Meter Input - Nozzle
1362	Custom Meter Input - Venturi
1363	Custom Meter Input - Flow Tube
1369	Critical Drop ASME Nozzle
1370	Critical Drop ISO Cylindrical Nozzle
1373	Critical Drop Sharp Edge Orifice Plate
1374	Critical Drop Thick Plate Orifice Plate
1690	Wedge Meter - Generic
1691	Wedge Meter - ABB Model 1610
1692	Wedge Meter - ABB Model 1615
1693	Wedge Meter - ABB Model 1630
1694	Wedge Meter - ABB Model 1335
1695	Wedge Meter - ABB Model 1336
1696	Wedge Meter - ABB Model 1337
1762	Custom Meter - Wedge

[I28] = Integer value is obsolete and no longer used.

[I29] = Integer value to determine venturi exit cone angle as follows:

INTEGER	EXIT CONE ANGLE
1160	15 Degree Exit Cone
1161	7 Degree Exit Cone

[I30] = Integer value to determine integral flow orifice assembly manufacturer as follows:

INTEGER	INTEGRAL ORIFCE MFR
1143	Foxboro
1144	Fisher-Rosemount

[I31] = Integer value to determine integral flow orifice assembly bore style and/or size as follows:

INTEGER	INTEGRAL ORIFICE SIZE/TYPE
1145	1/2 in. Quadrant-edge
1146	1/2 in. Square-edge
1147	1 in. Square-edge
1148	1-1/2 in. Square-edge

[I32] = Integer value to determine integral flow orifice assembly pipe material as follows:

INTEGER	MATERIAL
1	< 5% Chrome Moly
2	300 Series Stainless Steel
3	301 Stainless Steel
4	304/304L Stainless Steel
5	310/310S Stainless Steel
6	316/316L Stainless Steel
7	330 Stainless Steel
8	347/348 Series Stainless Steel
9	400 Series Stainless Steel
10	5%-9% Chrome Moly
11	Aluminum Bronze (ASTM B169 ALLOY A)
12	Beryllium-Copper
13	Carbon Steel
14	Carpenter 20 / Alloy 20
15	Commercial Bronze
16	Copper (ASTM B152, B124, B133)
17	Cupro-Nickel 30 pct
18	Hastelloy B
19	Hastelloy C
20	Inconel 600
21	Inconel 625
22	Inconel 800
23	Inconel X, Annealed
24	K-monel
25	Monel 400
26	Nickel
27	Nickel 200
28	Phospher Bronze
29	Pyrex Glass
30	Haynes Stellite 25
31	Tantalum

32	Teflon
33	Titanium
34	Yellow Brass (ASTM B36, B134)
35	Zirconium
36	P2 Chrome Moly Steel
37	P11 Chrome Moly Steel
38	P12 Chrome Moly Steel
39	P22 Chrome Moly Steel
40	P91 Chrome Moly Steel

[I33] = Integer input to specify the orifice meter tap style. The tap style values are defined as follows:

For concentric bore orifice plates

INTEGER	TAP STYLE
1	Flange taps
2	Corner taps
3	Radius taps D & D/2
4	Pipe taps 2-½D & 8D

For segmental bore orifice plates

INTEGER	TAP STYLE
1	Flange taps
2	Vena contracta taps

For eccentric bore orifice plates (RW Miller Standard)

INTEGER	TAP STYLE
1	Flange taps - 180 degree top
2	Flange taps - 90 degree side
3	Vena contracta - 180 degree top
4	Vena contracta - 90 degree side

For eccentric bore orifice plates (ISO/TR 15377 Compliant)

INTEGER	TAP STYLE
1	Flange taps
2	Corner taps

For integral orifice meter assemblies

INTEGER	TAP STYLE
1	Quadrant-edged - ½ inch diameter
2	Square-edged - ½ inch diameter
3	Square-edged - 1 inch diameter
4	Square-edged - 1-½ inch diameter

For honed small bore pipe orifice assemblies, quadrant-edged orifice plates or conic orifice plates

INTEGER	TAP STYLE
1	Flange taps
2	Corner taps

[I34] = Integer input to determine the pressure tap location in relation to the meter bore.

INTEGER	LOCATION
0	Upstream
1	Downstream

[I35] = Integer value to determine pipe material as follows:

INTEGER	MATERIAL
1	< 5% Chrome Moly
2	300 Series Stainless Steel
3	301 Stainless Steel
4	304/304L Stainless Steel
5	310/310S Stainless Steel
6	316/316L Stainless Steel
7	330 Stainless Steel
8	347/348 Series Stainless Steel
9	400 Series Stainless Steel
10	5%-9% Chrome Moly (P11, P12,
11	Aluminum Bronze (ASTM B169 ALLOY A)
12	Beryllium-Copper
13	Carbon Steel
14	Carpenter 20 / Alloy 20
15	Commercial Bronze
16	Copper (ASTM B152, B124, B133)
17	Cupro-Nickel 30 pct
18	Hastelloy B
19	Hastelloy C
20	Inconel 600
21	Inconel 625
22	Inconel 800
23	Inconel X, Annealed
24	K-monel
25	Monel 400
26	Nickel
27	Nickel 200
28	Phospher Bronze
29	Pyrex Glass
30	Haynes Stellite 25
31	Tantalum
32	Teflon
33	Titanium
34	Yellow Brass (ASTM B36, B134)
35	Zirconium
36	P2 Chrome Moly Steel
37	P11 Chrome Moly Steel
38	P12 Chrome Moly Steel
39	P22 Chrome Moly Steel
40	P91 Chrome Moly Steel

[I36] = Integer value to determine element material as follows:

INTEGER	MATERIAL
1	< 5% Chrome Moly
2	300 Series Stainless Steel
3	301 Stainless Steel
4	304/304L Stainless Steel
5	310/310S Stainless Steel
6	316/316L Stainless Steel
7	330 Stainless Steel

8	347/348 Series Stainless Steel
9	400 Series Stainless Steel
10	5%-9% Chrome Moly
11	Aluminum Bronze (ASTM B169 ALLOY A)
12	Beryllium-Copper
13	Carbon Steel
14	Carpenter 20 / Alloy 20
15	Commercial Bronze
16	Copper (ASTM B152, B124, B133)
17	Cupro-Nickel 30 pct
18	Hastelloy B
19	Hastelloy C
20	Inconel 600
21	Inconel 625
22	Inconel 800
23	Inconel X, Annealed
24	K-monel
25	Monel 400
26	Nickel
27	Nickel 200
28	Phospher Bronze
29	Pyrex Glass
30	Haynes Stellite 25
31	Tantalum
32	Teflon
33	Titanium
34	Yellow Brass (ASTM B36, B134)
35	Zirconium
36	P2 Chrome Moly Steel
37	P11 Chrome Moly Steel
38	P12 Chrome Moly Steel
39	P22 Chrome Moly Steel
40	P91 Chrome Moly Steel

[I37] = Integer value to determine pipe schedule as follows:

Stainless Steel Materials

INTEGER	SCHEDULE
0	Sch 5S
1	Sch 10S
2	Sch 40S
3	Sch 80S
4	User Input

Carbon and Chrome Moly Materials

INTEGER	SCHEDULE
0	Sch 10
1	Sch 20
2	Sch 30
3	Sch STD
4	Sch 40
5	Sch 60
6	Sch XS
7	Sch 80

		8	Sch 100
		9	Sch 120
		10	Sch 140
		11	Sch 160
		12	Sch XXS
		13	User Input
[I38]	=	Integer value to determine calculation mode as follows:	
		INTEGER	CALCULATION MODE
		1123	Flow meter sizing
		1124	Critical drop restriction sizing
		1125	Pressure drop restriction sizing
[I39]	=	Integer value to determine discharge coefficient standard as follows:	
		INTEGER	DISCHARGE COEFFICIENT STANDARD
		1137	ASME MFC 3M/ISO5167 (1991) Equation - Plates, Nozzles, & Venturi
		1138	AGA Report 3 (1992) Equation - Plates
		1139	AGA Report 3 Buckingham (Spinks) 1985 Equation
		1703	ISO 5167 (2003)/ASME MFC 3M (2004) for Plates
		1704	ISO 5167 (2003)/ASME MFC 3M (2004) for Venturi
		1752	ISO 5167 (2003)/ASME MFC 3M (2004) for Nozzles
		1753	PTC 6 Throat Tap Flow Nozzle
		1765	ISO/TR 15377 Eccentric, Quadrant, Conic Plates
[I40]	=	Integer value to determine calculation sizing parameter as follows:	
		INTEGER	CALCULATION SIZING PARAMETER
		1120	Bore
		1121	Meter dP
		1122	Flow
[I41]	=	Integer value representing current calculation revision.	
[D01]	=	Double precision data for the selected flow conversion factor.	
[D02]	=	Double precision data for the selected pressure conversion factor.	
[D03]	=	Double precision data for the selected base pressure conversion factor.	
[D04]	=	Double precision data for the selected atmospheric pressure conversion factor.	
[D05]	=	Double precision data for the selected differential pressure conversion factor.	
[D06]	=	Double precision data for the selected density conversion factor.	
[D07]	=	Double precision data for the selected viscosity conversion factor.	
[D08]	=	Double precision data for the selected velocity conversion factor.	
[D09]	=	Double precision data for the selected local gravity constant conversion factor.	
[D10]	=	Double precision data for the selected bore conversion factor.	
[D11]	=	Double precision data for the selected nominal pipe diameter conversion factor.	
[D12]	=	Double precision data input for meter maximum flow.	
[D13]	=	Double precision data input for meter normal flow.	
[D14]	=	Double precision data input for flowing condition pressure.	
[D15]	=	Double precision data input for flowing condition temperature.	
[D16]	=	Double precision data input for flowing condition density, specific gravity, or compressibility depending on fluid type.	
[D17]	=	Double precision data input for base pressure.	

[D18] = Double precision data input for base temperature.

[D19] = Double precision data input for base condition density, specific gravity or compressibility depending on fluid type.

[D20] = Double precision data input for meter maximum differential pressure.

[D21] = Double precision data input for meter normal differential pressure.

[D22] = Double precision data input for permanent pressure loss in percent of maximum dP.

[D23] = Double precision data output for meter expansion factor.

[D24] = Double precision data output for pipe thermal expansion correction factor.

[D25] = Double precision data input for seal fluid density required for manometer correction factor.

[D26] = Double precision data input for seal fluid temperature at meter required for manometer correction factor.

[D27] = Double precision data input for value of local acceleration due to gravity required for manometer correction factor.

[D28] = Double precision data input for diameter of drain/vent hole.

[D29] = Double precision data input for water vapor pressure used in calculating the water vapor correction factor.

[D30] = Double precision data output for the water vapor correction factor.

[D31] = Double precision data input for vapor quality weight fraction or saturated liquid weight fraction (in percent).

[D32] = Double precision data for input liquid density for vapor quality correction.

[D33] = Double precision data input for nominal pipe diameter

[D34] = Double precision data input for actual inner pipe diameter

[D35] = Double precision data input for viscosity.

[D36] = Double precision data input for gas/vapor specific heat ratio or liquid compressibility depending on fluid type.

[D37] = Double precision data input for following parameters:

- Gas volume flow or vapor mass flow calculation with PVT equation - molecular weight of gas or vapor.
- Gas or vapor critical flow calculation with density equation - molecular weight of gas or vapor.
- Liquid critical drop calculations - vapor pressure of liquid.
- Saturated liquid two phase calculation - density of vapor portion of fluid.

[D38] = Double precision data output for percent of flow for which beta calculated compared to maximum flow value or upper range value of meter.

[D39] = Double precision data output for drain/vent hole correction factor.

[D40] = Double precision data input for water vapor correction factor for gases or vapors.

[D41] = Double precision output data for quality factor for vapor mass flow calculations.

[D42] = Double precision data output for manometer correction factor.

[D43] = Double precision data output for meter sizing factor.

[D44] = Double precision data output for Reynolds number at normal flow condition.

[D45] = Double precision data output for expansion factor for gases and vapors.

[D46] = Double precision data input/output for meter discharge coefficient.

[D47]	=	Double precision data output for radius of quadrant (for quadrant style orifice plates) or the flow coefficient including approach factor for Buckingham discharge coefficient.
[D48]	=	Double precision data input for specific heat ratio (K) for gases or vapors.
[D49]	=	Double precision data output for velocity of approach factor (Buckingham discharge coefficient standard) or static to total pressure factor for critical drop calculations for gases or vapors.
[D50]	=	Double precision data output for calculated Beta ratio (d/D).
[D51]	=	Double precision data input/output for calculated bore.
[D52]	=	Double precision data output for segment height for segmental orifice plates. Automatically calculated. Can be set to 0.0 for data import.
[D53]	=	Double precision data output for segment diameter for segmental orifice plates.
[D54]	=	Double precision data input for differential pressure meter reference temperature.
[D55]	=	Double precision data output for dP reference temperature correction factor. Automatically calculated. Can be set to 0.0 for data import.
[D56]	=	Double precision data input for atmospheric pressure.
[D57]	=	Double precision data output for calculated meter uncertainty.
[D58]	=	Double precision data output for calculated system uncertainty.
[D59]	=	Double precision data output for calculated throat velocity.
[D60]	=	Double precision data output for minimum plate thickness.
[D61]	=	Double precision data input for specification data sheet maximum pressure.
[D61]	=	Double precision data input for specification data sheet maximum temperature.

The following example illustrates an FE-Sizer export file for a single meter tag (FE-1001) as it would look if viewed with an ASCII text viewer or editor:

```
Tag_No,Service,Line_No,Date,Name,Memo,Fluid,Meter,Meter_Type,Tap_Style,
Elem_Matl,Pipe_Matl,Pipe_Sched,Mfr,Model,Spec_No,Rev_No,By,Chk,Spec_Date,
Rev_No_1,Rev_No_2,Rev_No_3,Rev_No_4,Rev_By_1,Rev_By_2,Rev_By_3,Rev_By_4,
Rev_Date_1,Rev_Date_2,Rev_Date_3,Rev_Date_4,Sht_No,Sht_Of,Pid_No,Elem_Matl,
Elem_Body,Elem_Thick,Elem_Construct,Elem_End_Conn,Tap_Quant,Tap_Size,
Tap_Orient, Pipe_Matl,Pipe_Conn_Rate,Pipe_Ups,Pipe_Down,Pipe_Run_By,
Meter_Type,Meter_Chart,Meter_Mult,Flange_By,Flange_Rate,Flange_Type,
Flange_Matl,Access_Vanes,Access_Studs,Access_Nuts,Access_Gaskets,
User_Line1_1,User_Line1_2,User_Line2_1,User_Line2_2,User_Line3_1,
User_Line3_2,User_Line4_1,User_Line4_2,User_Line5_1,User_Line5_2,
User_Notes_1,User_Notes_2,User_Notes_3,User_Misc,Unit_Flow_Set,
Unit_Press_Set,Unit_BasePress_Set,Unit_AtmPress_Set,Unit_DpPress_Set,
Unit_Temp_Set,Unit_BaseTemp_Set,Unit_DpRefTemp_Set,Unit_Dens_Set,
Unit_Visc_Set,Unit_Velocity_Set,Unit_GLocal_Set,Unit_Bore_Set,
Unit_Pipe_Set,Unit_PressSys_Set,Fluid_Equation,Fluid_Condition,
Fluid_Property,Factor_Manometer,Factor_Drain,Factor_DrainType,
Factor_Drain_HoleSel,Factor_H2OvapSetup,Factor_H2OvapIncl,Factor_SatLiq,
Factor_VapQual,Meter_Type,Meter_Style,Meter_VenturiExit,Meter_IFOAMfr,
Meter_IFOASize,Meter_IFOAPipeMatl,Tap_Style,Tap_Loc,Matl_Pipe,Matl_Elem,
Pipe_Sched,Calc_Mode,Calc_Std,Calc_SizeParam,Calc_Rev,Unit_Flow,Unit_Press,
Unit_BasePress,Unit_AtmPress,Unit_Dpress,Unit_Dens,Unit_Visc,Unit_Velo,
Unit_Glocal,Unit_Bore,Unit_Pipe,Flow_Max,Flow_Norm,Flow_Press,Flow_Temp,
Flow_RhoGZ,Base_Press,Base_Temp,Base_RhoGZ,Dp_Max,Dp_Norm,Dp_Loss,Fa_Meter,
Fa_Pipe,Factor_ManoSealRho,Factor_ManoSealTemp,Factor_ManoGlocal,
Factor_DrainDia,Factor_PwvEdit,Factor_Pwv,Factor_QualX,Factor_QualRho,
Pipe_NomDia,Pipe_IDia,Property_Visc,Property_KFp,Property_MwDenVp,PctRange,
Fdh,Fwv,Fx,Fm,Sm,Rd,Y,C,Qrad_K0,K,E_Ftp,Beta,Bore,SegHs,SegDc,DpRefTemp,
DpRefFact,AtmPress,MeterUncert,SystemUncert,Velocity,Min_Thick,Max_Press,
Max_Temp
FE-1001,COMPRESSOR RECYCLE,4"ER-0001,24 Feb 2002,J.Milling,,ETHYLENE,
ORIFICE PLATE,,FLANGE TAPS,300 Series SS,CARBON STEEL,STD,*,*,
FE-1,0,CSE,JWM,02/24/02,,,,,,,,,,,,,,,P&ID #1,316 SS,,1/8 INCH,,,ONE (1)
PAIR,1/2 INCH NPT,45 DEG UP,CARBON STEEL,300# ANSI RF FLANGED,80 INCHES,20
INCHES,VENDOR,DRY CAPSULE DIAPHRAGM,0-10 SQUARE ROOT,15·000 x READING =
SCFH,VENDOR,300# RF,WELD NECK,CARB STEEL,NONE,ASTM A193,ASTM A194,316 SS
SPIRAL WOUND GRAPHITE,,,OVERALL LENGTH FLG-FLG,*,DCS SCALE RANGE,0-150·000
SCFH,,,,,,,,* VENDOR TO FURNISH INFORMATION WITH QUOTATION,1,0,0,0,0,0,0,
0,0,0,0,0,0,0,0,1352,1354,1357,0,0,1187,0,1211,0,0,0,1128,1,1160,1143,1145,
13,1,1109,13,2,4,1123,1137,1120,0,1.000000,1.000000,1.000000,1.000000,
1.000000,1.000000,1.000000,1.000000,0.000000,1.000000,1.000000,
200000.000000,150000.000000,314.696000,559.670000,0.884400,14.695950,
519.670000,0.993600,100.000000,56.250000,66.835149,1.000293,1.000197,
0.000000,519.670000,1.#INF00,0.000000,0.949236,0.949236,0.000000,0.000000,
4.000000,4.026000,0.010980,1.226800,28.054000,75.000000,1.000000,1.000000,
1.000000,1.000000,0.198324,1594268.551167,0.997666,0.604775,0.000000,
0.000000,1.020827,0.558750,2.249526,0.000000,0.000000,527.670000,1.000000,
14.696000,0.604331,0.000000,88.982212,0.000000,389.696000,609.670000
```

9. FLUID PROPERTY CORRELATIONS

FE-Sizer requires accurate fluid property data to precisely size a flow meter application. However, for many sizing applications, fluid property data for the fluid in question is not available and must be estimated. Therefore, FE-Sizer includes reliable fluid property correlations to provide reasonable property estimates. Correlations include the ASME Steam Tables (1967 IPC Formulation for Industrial Use) for steam and water properties, Redlich-Kwong, Soave-Redlich-Kwong, and Benedict-Rubin-Webb for gases and vapors, and the Hankinson-Brobst-Thomson (HBT) technique for estimating compressed liquids. The following sections present the fluid property correlations that are available in FE-Sizer and how to use them.

9.1 Single Component & Multi-Component Fluid Selection Dialog

The *Single Component & Multi-Component Fluid Selection* dialog of Figure 9-1 allows you to define single and multi-component fluids. Use the dialog as follows.

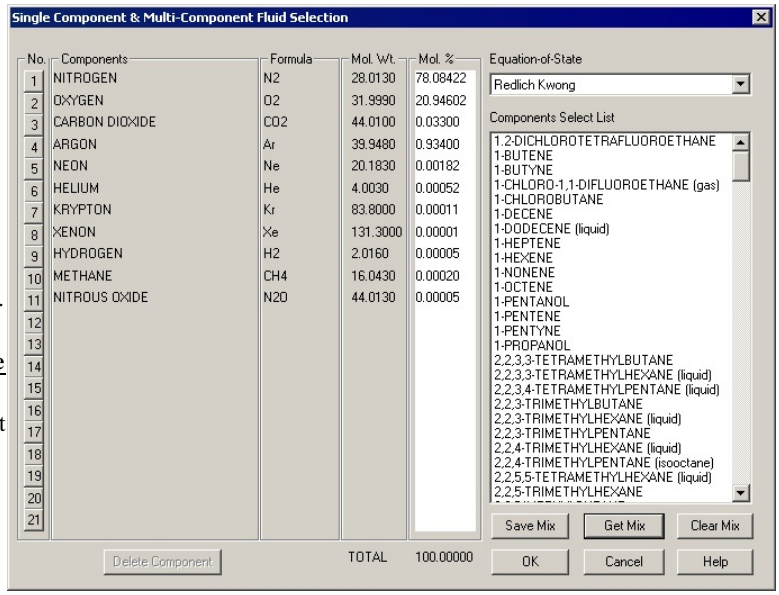


Figure 9-1

To setup the fluid components, complete the following steps . . .

Equation-of-State

Click the drop-down list box arrow on the right side or the list itself. For gases and vapors, you can select from the following equations-of-state . . .

1. Redlich Kwong.
2. Soave-Redlich Kwong.
3. Benedict-Web-Rubin.

For liquids, you can choose only the Hankinson-Brobst-Thomson equation.

The fluid conditions, i.e., base or flowing, will be automatically set those last used.

Components Select List

The *Components Select List* box shown in the lower right portioin of Figure 9-1 is used to select the component or components. For single component fluids, select only one component by double-clicking its entry in the list box. If the item is not visible, use the scroll button on the right side of the list box to *scroll* the item into view. Once the fluid is selected, calculate the properties by selecting the OK button with the

mouse. The mole percent is automatically set to 100% for all single component selections.

For multi-component fluids, double-click all the components that make up the fluid. You may pick up to 20 different fluids. As the fluids are selected, they are added to the *Components* list shown in the upper left to lower left portion of the *Single Component & Multi-Component Fluid Selection* dialog.

Once you have selected all the components, you must specify the mole percent (mole-fraction x 100%) for each component. The entries are below the *Mol. %* column. Use the TAB key to proceed to the next item. Once you have entered all the mole percents, check the total found at the bottom of the Mol. % column. This total must be exactly 100% before proceeding to the OK button. The OK button calculates the fluid properties for the specified mixture file.

Save Mix

The *Save Mix* button below the *Components Select List* allows you to save multi-component mixture files for later recall. It is recommended that you use this feature for large multi-component mixtures you use frequently to save time. When selected, the *Save As* dialog shown in Figure 9-2 is activated to set the file path and file name for the fluid mixture file.

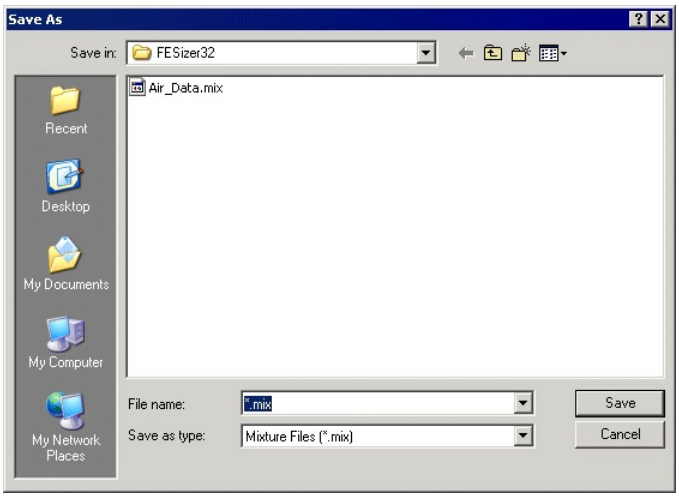


Figure 9-2

Get Mix

This button allows you to recall mixture files that have been saved to storage. It activates the *Open* dialog (functionally the same as Figure 9-2) for specifying the file path and name to retrieve.

Clear Mix

Use this button to clear all components from the components list. You are prompted to confirm clearing the list.

Component Buttons 1 thru 20

These button highlight the associated component row and activates the *Delete Row* button and is used to delete individual components from the mixture list.

Delete Row

This button, activated by any of the active *Components Buttons*, deletes the highlighted component. Only one component at a time can be deleted in this manner.

OK

Sets up the mixture table and calculates the fluid properties for the specified mixture or single component fluid.

Cancel

Cancels the *Single Component & Multi-Component Fluid Selection* dialog box without calculating the fluid properties.

Help

Displays the help topic associated with the *Single Component & Multi-Component Fluid Selection* dialog box.

9.2 Fluid Properties - Pressure and/or Temperature Data Dialog

Once you complete the fluid components selection of Figure 9.1 and clicked Ok, the *Fluid Properties - Pressure & Temperature Data* input dialog shown in Figure 9-3 is presented. For this dialog you enter the pressure and temperature which to calculate the fluid properties.

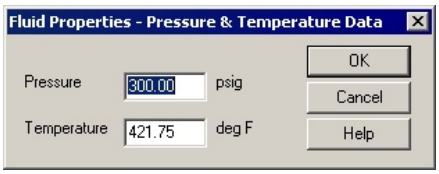


Figure 9-3

If determining conditions for saturated steam, either the temperature or pressure of the steam is required for the saturated steam property correlation. You enter the temperatures and pressures in the units specified.

9.3 Equations-of-State

Each of the equations-of-states have specific applications for estimating fluid properties.

Redlich Kwong

This highly recognized gas and vapor equation of state is applicable for reduced pressures ($P_r = P_f / P_c$) and reduced temperatures ($T_r = T_f / T_c$) greater than 1. This equation generally provides accurate results when these guidelines are followed.

Soave-Redlich Kwong

The Soave-Redlich-Kwong equation modifies the original Redlich-Kwong gas and vapor state equation to provide more accurate results for nonpolar molecules at or near saturated conditions. The user should note that this form of the Redlich-Kwong equation begins to deviate from actual values of specific volumes for reduced temperatures, T_r, greater than 1. This is because the Soave *a* parameter was curve fitted to vapor pressure data above reduced temperature of 1 that does not exist. Therefore, you should not use the Soave-Redlich-Kwong equation at large reduced temperatures.

Benedict-Webb-Rubin

The Benedict-Webb-Rubin gas vapor state equation is applicable over much broader pressure and temperature ranges. It generally produces accurate volume estimates for many applications and is a very good general equation to select.

Hankinson-Brobst-Thomson

Correlation for estimating pure liquid specific volumes or densities. The original Hankinson-Brobst-Thomson equation was extended by Thomson to allow prediction of compressed liquid volumes.

The actual equations and methods for estimating fluid properties is beyond the scope of FE-Sizer. However, all correlations used in FE-Sizer were based on the book by Robert C. Reid, John M. Prausnitz, and Bruce E. Poling, “The Properties of Gases & Liquids,” Fourth Edition, McGraw-Hill.

APPENDIX A - WARNING MESSAGES

WARNING #1 `The standard ratio limit of dP (inWC)/Pf (psia) <= 1.0 has been exceeded. Cannot guarantee accuracy of computed flow coefficient! Consult with your manufacturer!`

The recommended maximum dP/P_1 ratio with dP in inches of water at 68°F and P_1 in psia should not exceed 1.0. For dP/P_1 ratios > 1.0, the accuracy of the correlation for the expansion factor, Y, diminishes.

WARNING #2 `The minimum allowable line size for the selected orifice style is _____ in. Cannot guarantee accuracy of flow coefficient! Consult with your manufacturer!`

The selected line size is smaller than the minimum recommended for the selected orifice style. The discharge coefficient is affected by the unpredictable internal pipe roughness and internal dimension tolerances. In order to guarantee the accuracy of the calculated discharge coefficient for this meter size, the internal diameter must be "honed" to a known smoothness and internal diameter.

WARNING #3 `Recommended maximum pipe I.D. is ___ in. for meter type. Consult with your manufacturer!`

The pipe I.D. is outside of maximum recommended pipe I.D.for selected meter application. You should consult with your manufacturer for availibility of dP meters in this size.

WARNING #4
```
Recommended beta range is:
    _____ <= b <= _____
Calculated b is _____.
Flow coefficient accuracy shall diminish! Consult
with your manufacturer!
```

The calculated beta does not fall within the recommended beta range. Though the meter accuracy cannot be guaranteed, the flow measurement will be repeatable.

WARNING #5 `Cannot save calculation without tag number! Assign tag number prior to selecting the save command.`

You must enter a tag number for the current calculation record before attempting to save it to the project database.

WARNING #6
```
Minimum pipe Reynolds number for this application
is _____.
Calculated Reynolds number is _____.
Cannot guarantee accuracy of flow coefficient!
Consult with your manufacturer!
```

The calculated Reynolds number for the pipe inside diameter is less than the minimum recommended Reynolds number for this meter style. The discharge flow coefficient shall be very sensitive to flow and the accuracy of the application cannot be guaranteed.

WARNING #7 `Maximum pipe Reynolds number for this application is _____.`
`Calculated Reynolds number is _____.`
`Cannot guarantee accuracy of flow coefficient!`
`Consult with your manufacturer!`

The calculated Reynolds number for the pipe inside diameter is greater than the maximum recommended Reynolds number for this meter style. The calculated discharge flow coefficient is outside the range for the discharge coefficient correlation. The accuracy of the application cannot be guaranteed.

WARNING #8 `Minimum pipe Reynolds number for this application is _____.`
`Calculated Reynolds number is _____.`
`Suggest using quadrant or conical entrance orifice!`

The calculated Reynolds number for the pipe inside diameter is less than the minimum recommended Reynolds number for this meter style. The discharge flow coefficient shall be very sensitive to flow and the accuracy of the application cannot be guaranteed.

WARNING #9 `Minimum bore Reynolds number for this application is _____.`
`Calculated Reynolds number is _____.`
`Consult with your manufacturer!`

The calculated Reynolds number for the bore diameter is less than the minimum recommended Reynolds number for this meter style. The discharge flow coefficient shall be very sensitive to flow and the accuracy of the application cannot be guaranteed.

WARNING #10 `Maximum bore Reynolds number for this application is _____.`
`Calculated Reynolds number is _____.`
`Consult with your manufacturer!`

The calculated Reynolds number for the bore diameter is less than the maximum recommended Reynolds number for this meter style. The discharge flow coefficient shall be very sensitive to flow and the accuracy of the application cannot be guaranteed.

WARNING #11 `Cp/Cv ratio (k) must be greater than 1.0 in order to size orifice. Please check your data!`

The Cp/Cv ratio (k) must be greater than 1.0.

WARNING #12 `Maximum beta for this meter is: b <= _____`
`Calculated b is _____.`
`Maximum limits have been exceeded. User should proceed with caution! Consult with your manufacturer!`

The calculated beta ratio for the given application exceeds the maximum allowable beta ratio for the current flow meter style. You must change the meter differential, maximum flow rate, or pipe inside diameter in order to reduce the calculated beta.

WARNING #13 `Calculated drain/vent hole factor is greater than the maximum recommended Fdh of 1.02! Consult with your manufacturer!`

The given drain/vent hole for the given application results in the drain/vent hole factor exceeding the maximum acceptable value of 1.02. You must select a smaller drain/vent hole diameter. Refer to the drain/vent hole diameter table from the *Drain/Vent Hole* command from the factors menu.

WARNING #14 `You cannot set the reference temperature for the dP cell with the current dP units system.`

The current dP unit system is not a "density-based" units system, e.g., inches of water, mm of mercury, etc. Therefore, the current dP units system is insensitive to ambient temperature.

WARNING #15 `The dP reference temperature for the selected discharge coefficient standard should be 60°F.`

The current discharge coefficient standard (AGA Report 3/API 2530) requires a dP reference temperature of 60°F for the differential pressure units selected for the meter differential.

WARNING #16 `The dP reference temperature for the selected discharge coefficient standard should be 68°F.`

The current discharge coefficient standard (ASME MFC 3M/ISO 5167) requires a dP reference temperature of 68°F for the differential pressure units selected for the meter differential

WARNING #17 `Outside temperature limits for thermal expansion correlation for element material. Expansion factor for element material is defaulted to 1.000000.`

The current operating or flowing temperature is outside temperature limits of the selected element material. A material more resistant to the operating temperature should be selected.

WARNING #18 `Outside temperature limits for thermal expansion correlation for pipe material.\nExpansion factor for pipe material is defaulted to 1.000000.`

The current operating or flowing temperature is outside temperature limits of the selected piping material. A material more resistant to the operating temperature should be selected.

WARNING #19 `Calculated bore is less than 1.0 inch. You should not use a vent or drain hole for this application. Consult with your manufacturer!`

Drain holes are generally not recommended for meter bores that are less than 1.0 inches.

WARNING #20
```
H/D ratio must be < 1.0.
Re-enter a valid H/D ratio.
```

Valid H/D ratios must be less than 1.0. Check with your manufacturer's data for their standard H/D ratios and follow their recommended practice.

WARNING #21
```
The given tag name is existing in the project file!
Replace the existing data with new data (y/n)?
```

The current calculation tag already exists within the project file. If you want to replace or overwrite the existing data in the project database, press "y" for yes. Otherwise press "n" for no.

WARNING #22
```
Minimum bore Reynolds number (Rd / ß) for this
application is ________.
Calculated bore Reynolds number (Rd / ß) is _____.
Try using quadrant entrance orifice!
Consult with your manufacturer!
```

Calculated bore Reynolds lies outside the recommended range for the selected orifice meter style. The discharge flow coefficient shall be very sensitive to flow and the accuracy of the application cannot be guaranteed. Check with your manufacturer for actual valid range for their orifice design.

WARNING #23
```
The given data set for this calculation appears not
to fit the Quadrant orifice calculation for this
vendor. The selected meter orifice style appears to
work for extremely low flows only. Try the 1/2 in.
square-edged integral orifice design.
```

Integral orifice warning message where the beta value cannot be resolved for the quadrant orifice of the selected manufacturer. Try to solve with the standard ½ in square-edged integral orifice design. If Reynolds number is low for the conventional square-edged design, consult with the manufacturer.

WARNING #24
```
Maximum pipe size of 36 in. (900 mm) has been
exceeded. Cannot determine plate thickness.
```

Cannot determine the plate thickness for this size pipe.

WARNING #25
```
Valid temperature range for H-B-T liquid density
correlation must be extrapolated. Cannot guarantee
accuracy of calculated density due to
extrapolation.
```

Given liquid flowing temperature is outside the valid temperature limits for the Hankinson-Brobst-Thomson liquid density correlation. Though the liquid density has been calculated through extrapolation of the correlation, there is no guarantee for its accuracy.

WARNING #26
```
Pipe diameter must be 1.5 in (40 mm) or greater to
use flange taps with this style orifice meter.
Use corner taps instead.
```

Flange taps for pipe sizes < 1.5 in is not compliant with ISO 15377 for quadrant entrance orifices. Select corner taps instead.

WARNING #27 Unused

WARNING #28 Selected fluid component is in the liquid state at base conditions! Can only determine the gas/vapor properties at the flowing condition.

You selected base condition flow units for the current fluid. However, the selected fluid component(s) from the properties correlation indicate that this fluid is a liquid at base conditions. Therefore, the flow properties can only be determined at the flowing conditions and the selected flow equation has been changed from base condition volumetric units to flowing condition volumetric units.

WARNING #29 Selected fluid is in the vapor state at base conditions! Can only determine the liquid properties at the flowing condition.

You selected base condition flow units for the current fluid. However, the selected fluid component from the properties correlation indicate that this fluid is a vapor at base conditions. Therefore, the flow properties can only be determined at the flowing fluid temperature and the selected flow equation has been changed from base condition volumetric units to volumetric units at flowing temperature.

WARNING # 30 Current liquid sizing indicate application is cavitating at MAXIMUM conditions and the flow is choked. Decrease sizing dP or increase P1 and try again.

Your selected sizing conditions that result in cavitation downstream and the flow will be choked at the maximum flow condition. You can get this warning for either flow meter sizing or differential pressure restriction sizing. To fix this situation you should either reduce your sizing differential pressure or increase the inlet pressure, or both.

WARNING # 31 Current liquid sizing indicate application is flashing at MAXIMUM conditions and the flow is choked. Decrease sizing dP or increase P1 and try again.

Your selected sizing conditions that result in flashing downstream and the flow will be choked at the maximum flow condition. You can get this warning for either flow meter sizing or differential pressure restriction sizing. To fix this situation you should either reduce your sizing differential pressure or increase the inlet pressure, or both.

WARNING # 32 Current liquid sizing indicate application is cavitating at NORMAL conditions and the flow is choked. Decrease sizing dP or increase P1 and try again.

Your selected sizing conditions that result in cavitation downstream and the flow will be choked at the normal flow condition. You can get this warning for either flow meter

sizing or differential pressure restriction sizing. To fix this situation you should either reduce your sizing differential pressure or increase the inlet pressure, or both.

WARNING # 33 `Current liquid sizing indicate application is flashing at NORMAL conditions and the flow is choked. Decrease sizing dP or increase P1 and try again.`

Your selected sizing conditions that result in flashing downstream and the flow will be choked at the normal flow condition. You can get this warning for either flow meter sizing or differential pressure restriction sizing. To fix this situation you should either reduce your sizing differential pressure or increase the inlet pressure, or both.

WARNING #34 thru #99 `Unused.`

WARNING # 1001 `The "FESIZER.CFG" file is not present! Creating default file.`

This warning message is encountered when the FESIZER.CFG file is missing or has been purposely erased to recover from a corrupted file, e.g., corrupted units, etc. The FESIZER.CFG file shall be reconstructed from memory.

WARNING # 1002 `Current project file is from a release prior to Release 3.22! Converting to the current will make the file incompatible with prior releases. Do you want to convert this file to Release 3.22?.`

This warning message is encountered when you are opening a data file that has been created on a Release prior to 3.22. You should back up the file prior to continuing in case the conversion process causes corruption of the data file.

APPENDIX B - ERROR MESSAGES

ERROR #1 `The data entered will not iterate to a valid solution. Check your data carefully!`

Fluid and/or sizing data and/or meter/pipe data will not iterate to a valid sizing parameter. You must examine the data carefully to insure validity.

ERROR #2 `The pipe size must be 1/2" <= D <= 1-1/2" for small bore honed orifice meter runs. Change pipe size!`

The flow coefficient, "C," for small bore honed orifice meters is only valid for ½ inch through 1-1/2 inch. You must select a different meter style.

ERROR #3 `Critical input data necessary for the calculation is missing! Please complete all data before attempting to calculate the sizing parameter.`

Critical data in either the **Fluid Data** section or the **Sizing Data** section of the main screen is missing. You must complete all required data entries prior to calculating the sizing parameter.

ERROR #4 `No pipe I.D. exists for selected pipe size and schedule. Enter the pipe I.D. manually and/or reset the pipe schedule.`

You have selected a pipe schedule and nominal pipe size in which the pipe I.D. is not defined. You must either select the HONED schedule and enter the pipe I.D. manually or reselect the pipe schedule.

ERROR #5 `Maximum flow is less than the normal flow. Please correct prior to calculating!`

You have entered a value for the maximum flow rate that is less than the normal flow rate. The value for maximum flow must be greater than or equal to the normal flow rate.

ERROR #6
```
Value for vapor quality must be:
90.0 <= Quality <= 100.0
Please reenter value for quality!
```

You cannot use a vapor quality, x, less than 90.0% quality for the vapor quality correction factor.

ERROR #7
```
Value for vapor quality must be:
0.0 >= Quality >= 10.0
Please reenter value for quality!
```

You cannot use a vapor quality, x, greater than 10% quality for the saturated liquid correction factor.

ERROR #8 `Value for base pressure in absolute units must be greater than zero. Please re-enter a valid base pressure!`

Base pressure must be greater than 0 when using absolute units for pressure. You must re-einter a number greater than 0.

ERROR #9 `Value for base temperature in absolute units must be greater than zero. Please re-enter a valid base temperature!`

Base temperature must be greater than 0 when using absolute units for temperature. You must re-einter a number greater than 0.

ERROR #10
```
Error opening mixture file.
Please correct or recreate mixture file.
```

You are attempting to open a file that is not a defined FE-Sizer mixture file - “filename.mix” - or the mixture file has become corrupted.

ERROR #11
```
Orifice bore diameter is greater than the pipe
inside diameter.
Please enter an orifice bore that is smaller than
the Pipe I.D.!
```

You have entered an orifice bore that is greater than the pipe inside diameter for a flow or differential pressure sizing parameter. You must correct the orifice bore or the pipe inside diameter before you can calculate the sizing parameter.

ERROR #12
```
Component in mixture file is missing in the
"PROPERTY.DAF" file.
Please correct or recreate mixture file.
```

FE-Sizer cannot locate a component found in the mixuture file in the “PROPERTY.DAF” file. Possibly this component was deleted from the PROPERTY.DAF file. Either add the missing component back into the PROPERTY.DAF file or recreate this mixture file.

ERROR #13
```
Liquid vapor pressure is greater than or equal to
the upstream static pressure.
Cannot calculate the choked pressure drop!
```

The liquid vapor pressure must be less than the inlet pressure to remain in the liquid phase. Please correct the vapor pressure accordingly.

ERROR #14
```
Selected meter size is not a standard size for ABB
1615L wedge meter model.
Standard sizes are 0.5 inch (15 mm), 1 inch (25
mm), 1.5 inch (40 mm), and 2 inch (50 mm) only.
```

You have entered an invalid size for the particular wedge meter selected. Correct meter size to one of the sizes listed or select a different ABB wedge meter model.

ERROR #15

```
Selected meter size is not a standard size for ABB
1610L and 1630L wedge meter models.
Standard sizes are 0.5 inch (15 mm) through 24 inch
(600 mm) only.
Excludes following sizes: 0.75 inch (20 mm), 1.25
inch (30 mm), 3.5 inch (90 mm), and 5 inch (125
mm).
```

You have entered an invalid size for the particular wedge meter selected. Correct meter size to one of the sizes listed or select a different ABB wedge meter model.

ERROR #16

```
Selected meter size is not a standard size for
1335L through 1337L ABB integral wedge meter model.
Standard sizes are 1 inch (25 mm) and 1-1/2 inch
(40 mm) only.
```

You have entered an invalid size for the particular wedge meter selected. Correct meter size to one of the sizes listed or select a different ABB wedge meter model.

ERROR #17

```
Invalid or corrupted data file.
Cannot retrieve information.
Recommend deleting file!
```

The data file you have attempted to access is either corrupted or not an FE-Sizer data file. If the file is corrupted, it is recommended that you delete the file as FE-Sizer can no longer read it. If the file belongs to another application, move the file to a directory not associated with the FE-Sizer application.

ERROR #18

```
Given pressure and temperature condition indicate
that the fluid is in the liquid state!
Aborting...
```

The fluid property correlations for the selected fluid(s) indicate that it is in the liquid state at the given pressure and temperature. You have selected a gas or vapor sizing equation.

ERROR #19

```
Given pressure and temperature condition indicate
that the fluid is in the vapor state!
Aborting...
```

The fluid property correlations for the single or multi component fluid indicate that the fluid is in the vapor state at the given pressure and temperature. The selected sizing equation is for a liquid.

ERROR #20

```
The data entered for flow, dP, or line size does
not allow iteration to a valid solution.
Decrease flow or increase line size or dP!
```

Cannot find solution with the given data for the selected sizing parameter. Either decrease flow and increase line size or dP and try to solve again.

ERROR #21

```
Physical properties for one or more of the selected
fluid(s) are for vapor state only.
Reselect valid fluid for calculating liquid
properties.
```

The given inlet pressure and temperature of the selected fluid(s) indicate this fluid is a vapor and not a liquid for the given pressure and temperature. You need to reselect a valid fluid for calculating the liquid properties.

ERROR #22 `Unused`

ERROR #23 `The total mole percent must equal 100 percent before saving the mix properties!`

AGA Report 3 error indicating the mole percent for the entered mixture must total 100 percent before the mix can be saved to a mixture file.

ERROR #24 `The properties database file "PROPERTY.DAF" is not present. Cannot access the fluid properties database!`

The properties database is not in the current drive and/or directory where the program files are located. The properties database file "PROPERTY.DAF" must be in the same drive and directory path as the "FESIZER.EXE" executable file.

ERROR #25 `This fluid component has been selected already. To change, revise the mole percent!`

You have attempted to select a fluid component that has already been added to the fluid component list. Change mole percent of previous entry if necessary.

ERROR #26 `The total mole percent must equal 100 percent before calculating the mix properties!`

The total mole percent of the fluid components must total 100 percent before the fluid properties can be calculated.

ERROR #27 `The property data in the "PROPERTY.DAF" database is not complete for the selected fluid. Aborting ...`

The data in the properties database is not sufficient for the selected fluid to calculate all the required parameters for this fluid. This is a limitation of the resource file used to create the properties database and not a limitation within FE-Sizer itself.

ERROR #28 `The property data in the "PROPERTY.DAF" database is incomplete. Cannot determine fluid viscosity.`

The data in the properties database is not sufficient for the selected fluid to calculate the viscosity. You must determine the value for viscosity from other sources and manually enter the value. This is a limitation of the resource file used to create the properties database and not a limitation within FE-Sizer itself.

ERROR #29 `The property data in the "PROPERTY.DAF" database is incomplete. Cannot determine specific heat ratio.`

The data in the properties database is not sufficient for the selected fluid to calculate the specific heat ratio. You must determine the value for the specific heat ratio from other sources and manually enter the value. This is a limitation of the resource file used to create the properties database and not a limitation within FE-Sizer itself.

ERROR #30 `The Antoine's coefficient data in the "PROPERTY.DAF" database is incomplete. Cannot determine fluid vapor pressure.`

The data in the properties database is not sufficient for the selected fluid to calculate the vapor pressure to verify the fluid state at base conditions. This is a limitation of the resource file used to create the properties database and not a limitation within FE-Sizer itself.

ERROR #31 `Unused`

ERROR #32 `No project file is open. A project file must be open before performing this function.`

An attempt was made to perform a project related task with no project database file open. You must open a project file before performing all project tasks.

ERROR #33 `Unused`

ERROR #34 `An error occurred while re-indexing the project file. Cannot reconstruct the database index file.`

This error usually indicates the project database file has been corrupted and can no longer be re-indexed. The project file cannot be reconstructed.

ERROR #35 `Unused`

ERROR #36 `Error opening project batch calculation data check file. Cannot print errors to project data check file!`

An error occurred in attempting to create a project batch calculation data check file in the given drive and directory path. Check the file path of the **Utilities** pull-down menu to determine if the current path exists.

ERROR #37 `The given max meter differential exceeds the allowable pressure drop, i.e., downstream pressure is less than an absolute vacuum which is not physically possible!`

The calculated maximum meter differential exceeded the allowable pressure drop for the liquid critical drop application. This indicates that the downstream pressure must be less than an absolute vacuum in order to achieve choked flow and is not physically possible. The upstream pressure should be increased, if feasible, to eliminate this problem.

ERROR #38 `Sonic flow conditions exist for the given conditions.`
`Use critical drop equations to determine orifice sizing parameter!`

The given sizing conditions show that sonic flow conditions will exists at the orifice outlet for the sizing data. Change to critical drop equation to determine orifice sizing parameter or change given sizing data.

ERROR #39 `Unused`

ERROR #40 `Error encountered while attempting to open or create project database file. Database may have "Read-Only" mode set and will not allow write access.`

An error occurred in attempting to open or create a project database file. Check current project database check file in the given drive and directory path. Check the file path of the **Utilities** pull-down menu to determine if the current path exists.

ERROR #41 `Project database has been corrupted. Try re-indexing before attempting this function again.`

Attempt at reading current project database failed. This suggest that the database is corrupted. Try re-indexing the database using the Files/Utilities/Rebuild Project Index command.

ERROR #42 `Unable to locate project database. Check harddisk for proper location.`

Attempt at retrieving a tag record from the project database failed. Index file indicates there are tag records present. However, cannot locate the “project.fdb” database. It may have been inadvertently moved. Check file path to determine if the “project.fdb” file is present.

ERROR #43 `Error encountered while attempting to save/read calculation to/from project database. Database may have "Read-Only" mode set and will not allow write access.`

Attempt at saving current tag record failed. This suggest that the database may be in read-only mode. Check the database file status for “read-only” mode. File should be set to read/write mode..

ERROR #44 `Error encountered while attempting to read/save project database index file.`
`Database may corrupted...`

Error encountered accessing the project database index file. Check to determine if file still present in the project directory.

ERROR #45

```
Error encountered creating the batch calculation
check file. Prior check file may exist with read
only attribute set.
Aborting batch calculation...
```

FE-Sizer has attempted to remove any prior batch calculation check file and failed. No batch status file can be created. Check if file currently exists with read-only file attribute set. If so, either remove the file or change file attribute to read/write.

ERROR #46

```
Error encountered creating the ASCII export file.
Check if prior file exists with read only attribute
set.
```

The file export command failed for the given export file name. Check if file currently exists with read-only file attribute set. If so, either remove the file or change file attribute to read/write.

ERROR #47

```
Error occurred while opening or creating
project.\nCheck if prior file exists with read only
attribute set.\nAborting operation...
```

File open or creation error. Check if file of the same name exists with read only attribute set. If operating from a network drive, check access rights for your user name to that drive.

ERROR #48

```
Error occurred while attempting to create tag file.
Check if prior file exists with read only attribute
set.
Aborting operation... .
```

File open or creation error occurred while attempting to perform your last function. Possibly the tag index file "*project*.IDX" has been altered to be read only. If so, set file mode back to read/write mode.

ERROR #49

```
Error occurred while attempting to read tag file.
File may be corrupt.
Aborting operation...
```

Last function you performed attempted to open the tag file "*project*.IDX" and failed. This usually indicates the *project*.IDX file is corrupt. Delete this file and use the *Rebuild Project Index* function found in the ***/File/Utilities*** menu selection.

ERROR #50 through #100

```
Unused
```

ERROR #101

```
Error accessing the database index file.
Packing aborted! Try re-indexing the project
database.
```

While packing the current database an error was encountered indicating corrupt data. Try rebuilding the project database index file to correct this condition. If this fails, you must resort to your backup file created prior to the packing command.

ERROR #102 `Error creating a temporary pack file. Packing aborted!`

FE-Sizer attempted to create a temporary file, PROJECT.$$$ - where project is the name of the current project database without the extension. However, the create command failed. Check if the file currently exists and, if so, check file attribute for read/write status. Status must be read/write and not read-only for this file to allow FE-Sizer to remove the file when necessary.

ERROR #103 `Error accessing the project database file. Packing aborted!`

While packing the current database an error was encountered indicating corrupt data. Try rebuilding the project database index file to correct this condition. If this fails, you must resort to your backup file created prior to the packing command.

ERROR #104 `Error occurred while packing the project database file. Packing aborted!`

A serious error has occurred while FE-Sizer was packing the current project database file. This usually indicates a corrupted database file. Should this occur, you must resort to your backup file created prior to the packing command. However, this file may be corrupted also. Try exporting the file as an ASCII delimited file and importing as a new project database to see if any bad records can be flushed.

ERROR #105 `The file selected is not a valid import file. File Import aborted!`

The ASCII file you are attempting to import is not a valid FE-Sizer ASCII import file. Make sure you use quotes for string text delimiters in your import files.

ERROR #201 `Insufficient memory for operation. Close any other open applications and try again!`

There is insufficient memory for the current operation within FE-Sizer. Close any open applications you may have to free up additional memory for FE-Sizer to use. If there are no other applications open, check the system resources available in the About FE-Sizer help topic. They must be 50% or more.

ERROR #1001 `File Open Error! Cannot read "FESIZER.CFG"!`

This error usually indicates a corrupted “FESIZER.CFG” file. You remove the file manually and then restart FE-Sizer. Continuing could cause a Windows “General Protection Fault” error.

ERROR #1002 `File Open Error! Cannot write "FESIZER.CFG"`

Write access error occurred while attempting to change the “FESIZER.CFG” file. This usually indicates that the file attribute has somehow been changed to read-only status. Check that the file status is read/write for this file.

ERROR #1003

```
Configuration file "FESIZER.CFG" corrupted and
cannot remove. Please insure Dos file attribute is
set to READ/WRITE!
```

You encounter this error when starting FE-Sizer with a corrupted FE-Sizer configuration file. You must remove the file manually and then restart FE-Sizer. Continuing can cause a Windows “General Protection Fault” error.

ERROR #1004

```
FESIZER.DAT file not found. You must start the
program from the FE-Sizer drive and directory
specified in setup.
---> Aborting operation! <---
```

This file must be located in the working directory for FE-Sizer. Ensure that the file is in the working directory. If you have changed the working directory, place a copy of the “FESIZER.DAT” in the working directory.

ERROR #1005

```
The file, FESIZER.DAT, has unauthorized
modifications. Contact Control-Soft Enterprises
regarding this error message if you are a licensed
user and need a program fix.
```

The file, FESIZER.DAT was tampered with or modified and has blocked execution of FE-Sizer. Try reinstalling program from program disk to reinitialize this file. Otherwise, contact Control-Soft Enterprises for a program fix.

ERROR #1006

```
You have reached your maximum number of multiple
sessions for your current license.
Contact Control-Soft Enterprises should you
frequently encounter this message and need to
increase the number of users for your current
license.

Aborting operation!
```

You have reached the maximum number of users allowed by your current license or you have crashed FE-Sizer and left a hung user in the user tracking database. If the latter is true, change the current date on your computer system to tomorrow’s date and restart FE-Sizer and exit immediately. Change your system date back to the current date. This will clear the hung user from the user tracking database. If you frequently encounter this message you need to consider increasing the number of users for your current license. If you are encountering system crashes frequently, try to reproduce what is causing the crashes and report the condition to Control-Soft Enterprises.

ERROR #1007

```
Your license number does not match the list of
licensed maintenance users. Therefore, you are
unauthorized to use this release of FE-Sizer.
Contact Control-Soft Enterprises regarding this
error message if you feel it is in error.

Aborting operation!
```

If you have visited the FE-Sizer Maintenance download website and installed the latest update and encountered this message on restart, you have not subscribed to the Control-Soft Enterprises maintenance. Resort back to your backup by reversing the online instructions for backing up your file. If you feel you have a maintenance subscription but have encountered this message, contact Control-Soft Enterprises. If you do not have a maintenance subscription you will need to add one to obtain the latest updates. Contact Control-Soft Enterprises for details.

.

APPENDIX C - PROGRAM EQUATIONS

Sizing-Factor S_M Equations for U.S. Flow Units

Gases - Volumetric Flow Rate at Base Conditions - PVT Equation

$$S_M = \frac{Q_n \sqrt{Z_{fl}\, T_{fl}\, M_W}}{1175.808\, Z_b\, T_b\, D^2 \sqrt{dP_n\, P_{fl}}} \qquad \text{Eqn. (C-1)}$$

Gases - Volumetric Flow Rate at Base Conditions - Density Equation

$$S_M = \frac{Q_n\, D_b}{358.9268\, D^2 \sqrt{dP_n\, D_{fl}}} \qquad \text{Eqn. (C-2)}$$

Gases - Volumetric Flow Rate at Flow Conditions - PVT Equation

$$S_M = \frac{q_n \sqrt{P_{fl}\, M_W}}{1175.808\, D^2 \sqrt{dP_n\, Z_{fl}\, T_{fl}}} \qquad \text{Eqn. (C-3)}$$

Gases - Volumetric Flow Rate at Flow Conditions - Density Equation

$$S_M = \frac{q_n \sqrt{D_{fl}}}{358.9268\, D^2 \sqrt{dP_n}} \qquad \text{Eqn. (C-4)}$$

Vapors - Mass Flow Rate at Flow Conditions - PVT Equation

$$S_M = \frac{W_n \sqrt{Z_{fl}\, T_{fl}}}{589.6457\, D^2 \sqrt{dP_n\, G\, P_{fl}}} \qquad \text{Eqn. (C-5)}$$

Vapors - Mass Flow Rate at Flow Conditions - Density Equation

$$S_M = \frac{W_n}{358.9268\, D^2 \sqrt{dP_n}\, \sqrt{D_{fl}}} \qquad \text{Eqn. (C-6)}$$

Liquids - Volumetric Flow Rate at Base Conditions - Specific Gravity Equation

$$S_M = \frac{Q_n G_b}{194.2785 D^2 \sqrt{dP_n F_p G_f}} \qquad \text{Eqn. (C-7)}$$

Liquids - Volumetric Flow Rate at Base Conditions - Density Equation

$$S_M = \frac{Q_n D_b}{1534.262 D^2 \sqrt{dP_n F_p D_f}} \qquad \text{Eqn. (C-8)}$$

Liquids - Volumetric Flow Rate at Flow Conditions - Specific Gravity Equation

$$S_M = \frac{q_n \sqrt{F_p G_f}}{5.666455 D^2 \sqrt{dP_n}} \qquad \text{Eqn. (C-9)}$$

Liquids - Volumetric Flow Rate at Flow Conditions - Density Equation

$$S_M = \frac{q_n \sqrt{F_p D_f}}{44.74932 D^2 \sqrt{dP_n}} \qquad \text{Eqn. (C-10)}$$

Liquids - Mass Flow Rate at Flow Conditions - Specific Gravity Equation

$$S_M = \frac{W_n}{2834.529 D^2 \sqrt{dP_n F_p G_f}} \qquad \text{Eqn. (C-11)}$$

Liquids - Mass Flow Rate at Flow Conditions - Density Equation

$$S_M = \frac{W_n}{358.9268 D^2 \sqrt{dP_n F_p D_f}} \qquad \text{Eqn. (C-12)}$$

Reynolds Number Equations for U.S. Flow Units

Gases - Volumetric Flow Rate at Base Conditions - PVT Equation

$$R_D = \frac{Q\, M_W\, P_b}{1.69911\, Z_b\, T_b\, U\, D} \qquad \text{Eqn. (C-13)}$$

Gases - Volumetric Flow Rate at Base Conditions - Density Equation

$$R_D = \frac{6.315968\, Q\, D_b}{U\, D} \qquad \text{Eqn. (C-14)}$$

Gases - Volumetric Flow Rate at Flow Conditions - PVT Equation

$$R_D = \frac{q\, M_W\, P_{fl}}{1.69911\, Z_{fl}\, T_{fl}\, U\, D} \qquad \text{Eqn. (C-15)}$$

Gases - Volumetric Flow Rate at Flow Conditions - Density Equation

$$R_D = \frac{6.315968\, q\, D_{fl}}{U\, D} \qquad \text{Eqn. (C-16)}$$

Vapors - Mass Flow Rate at Flow Conditions - PVT & Density Equation

$$R_D = \frac{6.315968\, W}{U\, D} \qquad \text{Eqn. (C-17)}$$

Liquids - Volumetric Flow Rate at Base Conditions - Specific Gravity Equation

$$R_D = \frac{92.15008\, Q\, G_b}{U\, D} \qquad \text{Eqn. (C-18)}$$

Liquids - Volumetric Flow Rate at Base Conditions - Density Equation

$$R_D = \frac{1.477564\, Q\, D_b}{U\, D} \qquad \text{Eqn. (C-19)}$$

Liquids - Volumetric Flow Rate at Flow Conditions - Specific Gravity Equation

$$R_D = \frac{92.15008\ q\ G_f F_p}{U\ D} \qquad \text{Eqn. (C-20)}$$

Liquids - Volumetric Flow Rate at Flow Conditions - Density Equation

$$R_D = \frac{1.477564\ q\ D_f}{U\ D} \qquad \text{Eqn. (C-21)}$$

Liquids - Mass Flow Rate at Flow Conditions - Specific Gravity & Density Equation

$$R_D = \frac{6.315963\ W}{U\ D} \qquad \text{Eqn. (C-22)}$$

Note: Above Reynolds number equations calculate the Reynolds number, R_D, for the pipe inside diameter. To calculate the bore Reynolds number, R_d, substitute the meter bore diameter, d, for pipe inside diameter, D, in the equations shown. Remember that the flowing diameters, D or d, are calculated as $D_{(ref)} \times F_{aD}$ or $d_{(ref)} \times F_{ad}$, respectively.

β_0 Approximate Sizing Equations

Venturi

Machined Inlet

$$\beta_0 = [\ 1 + (\ 0.995 / S_M\ )^2\ ]^{-1/4} \qquad \text{Eqn. (C-23)}$$

Rough-cast Inlet

$$\beta_0 = [\ 1 + (\ 0.9845 / S_M\ )^2\ ]^{-1/4} \qquad \text{Eqn. (C-24)}$$

Rough-welded sheet iron

$$\beta_0 = [\ 1 + (\ 0.985 / S_M\ )^2\ ]^{-1/4} \qquad \text{Eqn. (C-25)}$$

Universal Venturi Tube†

$$\beta_0 = [\ 1 + (\ 0.9797 / S_M\ )^2\ ]^{-1/4} \qquad \text{Eqn. (C-26)}$$

Lo-Loss Flow Tube‡

$$\beta_0 = [\ 1 + (\ 0.92 / S_M - 0.31\ )^2\ ]^{-1/4}$$ **Eqn. (C-27)**

† From BIF CALC 440/441; the manufacturer should be consulted for exact coefficient information.
‡ Derived from Badge Meter, Inc. Lo-Loss flow-tube coefficient curve.

Nozzle

ASME Long Radius & Throat Tap

$$\beta_0 = [\ 1 + (\ 0.9975 / S_M - 0.31\ )^2\ ]^{-1/4}$$ **Eqn. (C-28)**

ISA

$$\beta_0 = [\ 1 + (\ 0.9944 / S_M - 0.188\ )^2\ ]^{-1/4}$$ **Eqn. (C-29)**

Venturi Nozzle (ISA Inlet)

$$\beta_0 = [\ 1 + (\ 0.989 / S_M - 0.09\ )^2\ ]^{-1/4}$$ **Eqn. (C-30)**

Orifice Plate

Corner, Flange, D and D/2 Taps

$R_D < 200{,}000$

$$\beta_0 = [\ 1 + (\ 0.6 / S_M - 0.06\ )^2\ ]^{-1/4}$$ **Eqn. (C-31a)**

$R_D \geq 200{,}000$

$$\beta_0 = [\ 1 + (\ 0.6 / S_M - 0.06\ )^2\ ]^{-1/4}$$ **Eqn. (C-31b)**

2½D and 8D (Pipe) Taps

$$\beta_0 = [\ 1 + (\ 0.61 / S_M + 0.55\ )^2\ ]^{-1/4}$$ **Eqn. (C-32)**

Eccentric, All Taps

$$\beta_0 = [\ 1 + (\ 0.607 / S_M + 0.088\ )^2\ ]^{-1/4}$$ **Eqn. (C-33)**

Segmental, All Taps

$$\beta_0 = [\ 1 + (\ 0.634 / S_M - 0.062\ )^2\ ]^{-1/4} \qquad \text{Eqn. (C-34)}$$

Quadrant ($\beta \leq 0.6$)

$$\beta_0 = [\ 1 + (\ 0.76 / S_M - 0.262\ )^2\ ]^{-1/4} \qquad \text{Eqn. (C-35)}$$

Conic, Corner ($\beta \leq 0.3$)

$$\beta_0 = [\ 1 + (\ 0.734 / S_M - 0.26\ )^2\ ]^{-1/4} \qquad \text{Eqn. (C-36)}$$

Equation for Reynolds Number Correction to Discharge Coefficient

$$C = C_\infty + b / R_D^n \qquad \text{Eqn. (C-37)}$$

Equation and Values for C∞, b, and n of Eqn. D-37				
Primary Device	Device Style	Discharge Coefficient, C∞ @ Infinite Reynolds number, $R_{D\infty}$	Coefficient b	Exponent n
Venturi ASME MFC-3M (1989 thru 2004) ISO 5167 (1991 thru 2003)	Machined Inlet	0.995	0	0
	Rough Cast Inlet	0.984	0	0
	Rough Welded Sheet-Iron Inlet ASME-MFC-3M (1989 only)	0.984		
	Rough Welded Sheet-Iron Inlet (all others)	0.985	0	0
Universal Venturi Tube	n/a	0.9797	0	0
Lo-Loss Flow Tube	n/a	$1.005 - 0.417\beta + 0.564\beta^2 - 0.514\beta^3$	0	0

Primary Device	Device Style	Discharge Coefficient, C∞ @ Infinite Reynolds number, $R_D\infty$	Coefficient b	Exponent n
Generic Wedge Meter	D = 0.5 in (12.5 mm)	$0.7883 + 0.107 \times (1 - \beta^{2}_{wedge})$	0	0
	D = 1 to 1.5 in. (25 to 75 mm)	$0.6143 + 0.718 \times (1 - \beta^{2}_{wedge})$	0	0
	D > 1.5 in. (75 mm)	$0.5433 + 0.2453 \times (1 - \beta^{2}_{wedge})$	0	0
Flow Nozzle	ASME Long Radius	0.9965	$-6.53\beta^{0.5}$	0.5
	ASME Throat Tap ASME PTC 6 1991	$9.971345E\text{-}01 + 4.998591e\text{-}4 \log(R_d) - 6.202481e\text{-}3 [\log(R_d)]^2 + 1.107620e\text{-}2 [\log(R_d)]^3 + 3.205253e\text{-}4 [\log(R_d)]^4 - 6.335702e\text{-}3 [\log(R_d)]^5 + 2.674624e\text{-}4 [\log(R_d)]^6 + 2.234238e\text{-}3 [\log(R_d)]^7 - 6.464382e\text{-}4 [\log(R_d)]^8$	$0.01134\beta - 0.0049$	0 (value for R_d^n is always 1.0)
	ISA	$0.9900 - 0.2262\beta^{4.1}$	$(-0.00175\beta + 0.0033\beta^{4.19}) \times 10^{6.9}$	1.15
	Venturi Nozzle ISA Inlet	$0.9558 - 0.196\beta^{4.5}$	0	0
Concentric Orifice (ISO 5167) Miller/Stolz Equations	Flange Taps $D \geq 2.3$ in.	$0.5959 + 0.0312\beta^{2.1} - 0.184\beta^{8} + 0.09 \{ {}^{4}/[D(1-\beta^4)]\} - 0.0337\beta^3/D$	$91.71\beta^{2.5}$	0.75
	Flange Taps $2 \leq D \leq 2.3$ in.	$0.5959 + 0.0312\beta^{2.1} - 0.184\beta^{8} + 0.039 \{\beta^4/[D(1-\beta^4)]\} - 0.0337\beta^3/D$	$91.71\beta^{2.5}$	0.75
	Corner Taps	$0.5959 + 0.312\beta^{2.1} - 0.184\beta^{8}$	$91.71\beta^{2.5}$	0.75
	Radius Taβs D and D/2	$0.5959 + 0.0312\beta^{2.1} - 0.184\beta^{8} + 0.039 \{\beta^4/[D(1-\beta^4)]\} - 0.0158\beta^3$	$91.71\beta^{2.5}$	0.75

Primary Device	Device Style	Discharge Coefficient, C∞ @ Infinite Reynolds number, $R_D\infty$	Coefficient b	Exponent n
	Pipe Taps 2½D and 8D	$0.5959 + 0.461\beta^{2.1} - 0.48\beta^{8} + 0.039\ \{\beta^4/[D(1-\beta^4)]\}$	$91.71\beta^{2.5}$	0.75
Eccentric Orifice	Flange 180° Taps D ≤ 4 in.	$0.5917 + 0.3061\beta^{2.1} - 0.3406\beta^{8} - 0.1019[\beta^4/(1-\beta^4)] - 0.2715\beta^{3}$	$7.3 - 15.7\beta + 170.8\beta^{2} - 399.7\beta^{3} + 332.2\beta^{4}$	0.75
	Flange 180° Taps D > 4 in.	$0.6016 + 0.3312\beta^{2.1} - 1.5581\beta^{8} + 0.6510[\beta^4/(1-\beta^4)] - 0.7308\beta^{3}$	$- 139.7 + 1328.8\beta - 4228.2\beta^{2} + 5691.9\beta^{3} - 2710.4\beta^{4}$	0.75
	Flange 90° Taps D ≤ 4 in.	$0.5866 + 0.3917\beta^{2.1} + 0.7586\beta^{8} - 0.2273[\beta^4/(1-\beta^4)] - 0.3343\beta^{3}$	$69.1 - 469.4\beta + 1245.6\beta^{2} - 1287.5\beta^{3} + 486.2\beta^{4}$	0.75
	Flange 90° Taps D > 4 in.	$0.6037 + 0.1598\beta^{2.1} - 0.2918\beta^{8} + 0.0244[\beta^4/(1-\beta^4)] - 0.0790\beta^{3}$	$- 103.2 + 898.3\beta - 2557.3\beta^{2} + 2977\beta^{3} - 1131.3\beta^{4}$	0.75
Eccentric Orifice *cont'd*	Vena Contracta 180° Taps D ≤ 4 in.	$0.5925 + 0.3380\beta^{2.1} + 0.4016\beta^{8} - 0.1046[\beta^4/(1-\beta^4)] - 0.3212\beta^{3}$	$23.3 - 207\beta + 821.5\beta^{2} - 1388.6\beta^{3} + 903.3\beta^{4}$	0.75
	Vena Contracta 180° Taps D > 4 in.	$0.5922 + 0.3932\beta^{2.1} + 0.3412\beta^{8} - 0.0569[\beta^4/(1-\beta^4)] - 0.4628\beta^{3}$	$55.7 - 471.4\beta + 1721.8\beta^{2} - 2722.6\beta^{3} + 1569.4\beta^{4}$	0.75
	Vena Contracta 90° Taps D ≤ 4 in.	$0.5875 + 0.3813\beta^{2.1} + 0.6898\beta^{8} - 0.1963[\beta^4/(1-\beta^4)] - 0.3366\beta^{3}$	$- 69.3 + 556.9\beta - 1332.2\beta^{2} + 1303.7\beta^{3} - 394.8\beta^{4}$	0.75

Primary Device	Device Style	Discharge Coefficient, C∞ @ Infinite Reynolds number, $R_D\infty$	Coefficient b	Exponent n
	Vena Contracta 90° Taps D > 4 in.	$0.5945 + 0.4078\beta^{2.1} + 0.0547\beta^{8} + 0.0955[\beta^4/(1-\beta^4)] - 0.5608\beta^3$	$52.8 - 434.2\beta + 1571.2\beta^2 - 2460.9\beta^3 + 1420.2\beta^4$	0.75
Segmental Orifice	Flange Taps D ≤ 4 in.	$0.6284 + 0.1462\beta^{2.1} - 0.8464\beta^{8} + 0.2603[\beta^4/(1-\beta^4)] - 0.2886\beta^3$	0	0
	Flange Taps D > 4 in.	$0.6276 + 0.0828\beta^{2.1} + 0.2739\beta^{8} - 0.0934[\beta^4/(1-\beta^4)] - 0.1132\beta^3$	0	0
	Flange Taps D ≤ 4 in.	$0.6261 + 0.1851\beta^{2.1} - 0.2879\beta^{8} + 0.1170[\beta^4/(1-\beta^4)] - 0.2845\beta^3$	0	0
	Flange Taps D > 4 in.	$0.6276 + 0.0828\beta^{2.1} + 0.2739\beta^{8} - 0.0934[\beta^4/(1-\beta^4)] - 0.1132\beta^3$	0	0
Quadrant Orifice	Corner & Flange Taps D ≥ 1.5 in.	$0.7746 - 0.1334\beta^{2.1} + 1.4098\beta^{8} + 0.0675[\beta^4/(1-\beta^4)] + 0.3865\beta^3$	0	0
Conic Orifice	D ≥ 1 in.	$250\beta \le R_D \le 500\beta$ 0.734 $5000\beta \le R_D \le 200{,}000\beta$ 0.730	0 0	0 0
Small Bore Honed Orifice Meter Assembly	Flange Taps ½ ≤ D ≤ 1½ in.	$[0.598 + 0.468(\beta^4+10\beta^{12})] \times (1 - \beta^4)^{0.5}$	$(0.87 + 8.1\beta^4) \times (1 - \beta^4)^{0.5}$	0.5
	Corner Taps ½ ≤ D ≤ 1½ in.	$[0.5991 + 0.0044/D + (0.3155 + 0.0175/D) \times (\beta^4 + 2\beta^{16})] \times (1 - \beta^4)^{0.5}$	$[0.52/D - 0.192 + (16.48 - 1.16/D) \times (\beta^4+4\beta^{16})] \times (1-\beta^4)^{0.5}$	0.5

Primary Device	Device Style	Discharge Coefficient, C∞ @ Infinite Reynolds number, $R_D\infty$	Coefficient b	Exponent n
Foxboro Integral Orifice Flow Assembly	Quadrant-edged D = ½ in.	$1.1126 - 99.13\beta^2 + 8006\beta^4 - 26{,}900\beta^8$	$-10.72\beta^{1/2} + 3823\beta^{5/2} - 309300\beta^{9/2}$	0.5
	Square-edged D = ½ in.	$0.6479 - 0.3505\beta^2 + 0.3853\beta^4 + 4.645\beta^8$	$-0.4356\beta^{1/2} + 33.49\beta^{5/2} - 88.33\beta^{9/2}$	0.5
	Square-edged D = 1 in.	$0.6050 - 0.1837\beta^2 + 0.6615\beta^4 - 1.094\beta^8$	$1.646\beta^{1/2} + 2.394\beta^{5/2} - 4.899\beta^{9/2}$	0.5
	Square-edged D = 1½ in.	$0.6122 - 0.1076\beta^2 + 0.3416\beta^4 - 0.684\beta^8$	$0.2368\beta^{1/2} + 14.3\beta^{5/2} - 12.86\beta^{9/2}$	0.5
Rosemount Integral Orifice Flow Assembly	Quadrant-edged D = ½ in.	1.005529	6.75	0.5
	Square-edged D = ½ in.	$0.5884229 - 0.07817863\beta + 1.205753\beta^2 - 3.378356\beta^3 + 2.854437\beta^4$	$3.146987 - 17.54468\beta + 56.26178\beta^2 - 77.01062\beta^3 + 52.11968\beta^4$	0.5
	Square-edged D = 1 in.	$0.595342 - 0.03890471\,\beta + 0.2588337\,\beta^2 - 0.346828\,\beta^3 + 0.07300363\beta^4$	$1.408031 + 0.6620094\beta - 6.079081\beta^2 + 12.17111\beta^3 + 6.377415\beta^4$	0.5
	Square-edged D = 1½ in.	$0.6051001 - 0.1111218\beta + 0.2830634\beta^2 + 0.040353\beta^3 - 0.3459831\beta^4$	$2.337983 - 13.71296\beta + 66.42804\beta^2 - 124.0909\beta^3 + 89.79559\beta^4$	0.5

Reader-Harris/Gallagher Flow Coefficient Correlation - API 2530/AGA Report No. 3 (1992)

Flange Taps

$$C = C_d(FT) = C_i(FT) + 0.000511\left(\frac{10^6\beta}{Re_D}\right)^{0.7} + (0.0210 + 0.00494A)\beta^4 C \quad \text{Eqn. (C-38)}$$

$$C_i(FT) = C_i(CT) + \text{Tap Term} \quad \text{Eqn. (C-39)}$$

Corner Taps

$$Cc = C_i(CT) = 0.5961 + 0.0291\beta^2 + -0.2290\beta^8 + 0.003(1-\beta)M_1 \quad \text{Eqn. (C-40)}$$

$$\text{Tap Term} = \text{Upstrm} + \text{Dnstrm} \quad \text{Eqn. (C-41)}$$

$$\text{Upstrm} = [0.0433 + 0.0712\,e^{-8.5L_1} - 0.1145\,e^{-6.0L_1}](1 - 0.23A)B \quad \text{Eqn. (C-42)}$$

$$\text{Dnstrm} = -0.0116[M_2 - 0.52M_2^{1.3}]\beta^{1.1}(1 - 0.14A) \quad \text{Eqn. (C-43)}$$

$$B = \frac{\beta^4}{1-\beta^4} \quad \text{Eqn. (C-44)}$$

$$M_2 = \frac{2L_2}{1-\beta} \quad \text{Eqn. (C-45)}$$

$$A = \left(\frac{19{,}000\beta}{R_D}\right)^{0.8} \quad \text{Eqn. (C-46)}$$

$$C = \left(\frac{10^6}{R_D} \right)^{0.35} \qquad \text{Eqn. (C-47)}$$

Buckingham Flow Coefficient Correlation

For Flange Taps

$$K = K_0 (1 + E_f \beta / R_D) \qquad \text{Eqn. (C-48)}$$

$$\begin{aligned} K_0 = {} & [0.5993 + 0.007 / D + (0.364 + \frac{0.076}{\sqrt{D}}) \beta^4 \\ & + 0.4 (1.6 - \frac{1}{D})^5 (0.07 + \frac{0.5}{D} - \beta)^{5/2} \\ & - (0.009 + \frac{0.034}{D}) (0.5 - \beta)^{3/2} \\ & + (\frac{0.65}{D^2} + 3) (\beta - 0.7)^{5/2}] \\ & \div [1 + 0.000015 (830 - 5000\beta + 9000\beta^2 - 4200\beta^3 + \frac{530}{\sqrt{D}})] \end{aligned} \qquad \text{Eqn. (C-49)}$$

$$E_f = d (830 - 5000\beta + 9000\beta^2 - 4200\beta^3 + \frac{530}{\sqrt{D}}) \qquad \text{Eqn. (C-50)}$$

For Corner Taps

$$K = K_0 (1 + 1000 E_C / \sqrt{R_D}) \qquad \text{Eqn. (C-51)}$$

$$K_0 = 0.6004 + 0.35 \beta^4 - 0.0525 (0.5 - \beta)^{3/2} + 0.62 - (\beta - 0.7)^{5/3} \qquad \text{Eqn. (C-52)}$$

$$E_C = (0.002 + 0.026 \beta^4) K_0 \qquad \text{Eqn. (C-53)}$$

For Radius (D & D/2) Taps

$$K = K_0\ 1 + 1000\,E_r/\sqrt{R_D} \qquad \text{Eqn. (C-54)}$$

$$K_0 = 0.6014 - 0.01352\,D^{1/4} + (0.3760 + 0.07257\,D^{1/4})\left[\frac{0.00025}{D^2\beta^2 + 0.0025\,D} + \beta^4 + 1.5\beta^{16}\right] \qquad \text{Eqn. (C-55)}$$

$$Er = 0.0002 + \frac{0.0011}{D} + \left(0.0038 + \frac{0.0004}{D}\right)\left[\beta^2 + (16.5 + 5D)\,\beta^{16}\right] \qquad \text{Eqn. (C-56)}$$

For Pipe (2½D and 8D) Taps

$$K = K_0\left(1 + E_p\,\beta/R_D\right) \qquad \text{Eqn. (C-57)}$$

$$K_0 = \left[0.5925 + \frac{0.0182}{D} + \left(0.440 - \frac{0.006}{D}\right)\beta^2 + \left(0.935 + \frac{0.225}{D}\right)\beta^5 + 1.35\,\beta^{14} + \frac{1.43}{\sqrt{D}}\left(0.25 - \beta\right)^{5/2}\right] \div \left[1 + 0.000015\left(905 - 5000\beta + 9000\beta^2 - 4200\beta^3 + \frac{875}{D}\right)\right] \qquad \text{Eqn. (C-58)}$$

$$E_p = d\left(905 - 5000\beta + 9000\beta^2 - 4200\beta^3 + \frac{875}{D}\right) \qquad \text{Eqn. (C-59)}$$

Buckingham Flow Coefficient of Discharge, C

$$C = K\sqrt{1 - \beta^4} \qquad \text{Eqn. (C-60)}$$

Reader-Harris/Gallagher Flow Coefficient Correlation - ISO 5167-2 (2003)

$$C = 0.5961 + 0.0261\,\beta^2 - 0.216\,\beta^8 + 0.000521\left[\frac{10^6\,\beta}{Re(D)}\right]^{0.7} + (0.0188 + 0.0063\,A)\,\beta^{3.5}\left[\frac{10^6}{Re(D)}\right]^{0.3} + (0.043 + 0.080e^{-10L_1} - 0.123\,e^{-7L_1})(1 - 0.11\,A)\frac{\beta^4}{1-\beta^4} - 0.031\,(M_2 - 0.8 - M_2^{1.1})\,\beta^{1.3} \qquad \text{Eqn. (C-61)}$$

where D < 71.12 mm (2.8 in.), the following term shall be added to Eqn. 61 above.

$$+ 0.011\,(0.75 - \beta)\left(2.8 - \frac{D}{25.4}\right) \qquad \text{Eqn. (C-62)}$$

For corner tappings:

$$L_1 = L_2 = 0$$

For D and D/2 tappings:

$$L_1 = 1$$

For flange tappings:

$$L_1 = L_2 = 25.4 / D$$

From Eqn (C-45)

$$M_2 = \frac{2\,L_2}{1 - \beta}$$

From Eqn. (C-46)

$$A = \left(\frac{19{,}000\,\beta}{R_D}\right)^{0.8}$$

Equation for Iterative Solution of

$$\beta_n = \left(1 + \left[\frac{F_{DH(n-1)}\,F_{X(n-1)}\,F_{WV(n-1)}\,F_{M(n-1)}\,C_{n-1}\,(Y_1)_{(n-1)}}{S_M}\right]^2\right)^{-1/4} \qquad \text{Eqn. (C-64)}$$

Gas/Vapor Expansion Factor Equations

Orifice Plates (Concentric, Integral Flow Orifice, and Honed Orifice)

ASME MFC-3M-1989, ISO-5167-1991, AGA ANSI/API 2530 Rpt 3-1992, & Spinks ANSI/API 2530 Rpt 3-1985

Upstream Tap Measurements, Y_1

$$Y_1 = 1 - (0.41 + 0.35\beta^4) \frac{X_2}{k \sqrt{1 + X_2}} \qquad \text{Eqn. (C-65a)}$$

ASME MFC-3M-2004 & ISO-5167-2003

$$Y_1 = 1 - (0.351 + 0.256\beta^4 + 0.93\beta^8) \left[1 - \left(\frac{P_2}{P_1} \right)^{1/K} \right] \qquad \text{Eqn. (C-65b)}$$

Contoured Primary Meters (Flow Nozzle, Venturi, Etc.)

Upstream Tap Measurements, Y_1

$$Y_2 = \sqrt{1 + x_2} - (0.41 + 0.35\beta^4) \frac{Xx_2}{k \sqrt{1 + X_2}} \qquad \text{Eqn. (C-66)}$$

$$Y_1 = \left[\frac{(1 - \beta^4)[k/(k-1)](P_{f2}/P_{f1})^{2/k}[1 - (P_{f2}/P_{f1})^{(k-1)/k}]}{[1 - \beta^4 (P_{f2}/P_{f1})^{2/k}](1 - P_{f2}/P_{f1})} \right]^{1/2} \qquad \text{Eqn. (C-67)}$$

Downstream Tap Measurements, Y_2

$$Y_2 = Y_1 \sqrt{1 + Xx_2} \qquad \text{Eqn. (C-68)}$$

Pressure Relationships

$$X_1 = dP / (27.73\ P_{f1}) \qquad \text{Eqn. (C-69)}$$

$$X_2 = dP / (27.73\ P_{f2}) \qquad \text{Eqn. (C-70)}$$

$$P_{f2}/P_{f1} = 1 - X_2 \qquad \text{Eqn. (C-71)}$$

$$P_{f2}/P_{f1} = 1/(1 + X_2) \qquad \text{Eqn. (C-72)}$$

Thermal Expansion Factor†

Primary Element, F_{ad}

$$F_{ad} = 1 + \alpha_{PE}(T_F - 68) \qquad \text{Eqn. (C-73)}$$

Pipe, F_{aD}

$$F_{aD} = 1 + \alpha_{P}(T_F - 68) \qquad \text{Eqn. (C-74)}$$

Table C1 - Coefficient of Thermal Expansion for Materials †

Material	Coefficient of Thermal Expansion	
	a, in/(in • °F)	Valid Temperature Range
301 SS	0.0000097 0.0000076	70 to 600 °F (21 to 315 °C) -300 to 70 °F (-185 to 21 °C)
304 SS	0.0000095 0.0000074	70 to 600 °F (21 to 315 °C) -300 to 70 °F (-185 to 21 °C)
310 SS	0.0000090 0.0000070	70 to 600 °F (21 to 315 °C) -300 to 70 °F (-185 to 21 °C)
316 SS	0.0000096 0.0000071	70 to 600 °F (21 to 315 °C) -300 to 70 °F (-185 to 21 °C)
330 SS	0.0000089 0.0000058	70 to 600 °F (21 to 315 °C) -300 to 70 °F (-185 to 21 °C)
347 SS	0.0000097 0.0000075	70 to 600 °F (21 to 315 °C) -300 to 70 °F (-185 to 21 °C)
Hastelloy B	0.0000056	32 to 212 °F (0 to 100 °C)
Hastelloy C	0.0000063	70 to 600 °F (21 to 315 °C)
Inconel X. annealed	0.0000067	70 to 600 °F (21 to 315 °C)
Haynes Stellite 25 (L605)	0.0000076	70 to 600 °F (21 to 315 °C)
Copper (ASTM B152, B124, B133)	0.0000093	70 to 600 °F (21 to 315 °C)
Yellow Brass (ASTM B36, B134, B135)	0.0000105	70 to 600 °F (21 to 315 °C)
Aluminum Bronze (ASTM B169 Alloy A)	0.0000092	70 to 600 °F (21 to 315 °C)
Commercial Bronze	0.0000101	70 to 600 °F (21 to 315 °C)
Phospher Bronze	0.0000099	70 to 600 °F (21 to 315 °C)
Beryllium Copper 25	0.0000093	70 to 600 °F (21 to 315 °C)
Cupronickel 30%	0.0000085	70 to 600 °F (21 to 315 °C)
K-Monel	0.0000074	70 to 600 °F (21 to 315 °C)
Monel 400	0.0000079 0.0000062	70 to 600 °F (21 to 315 °C) -300 to 70 °F (-185 to 21 °C)
Nickel	0.0000083	70 to 600 °F (21 to 315 °C)
Pyrex Glass	0.0000002	32 to 580 °F (0 to 300°C)
Titanium	0.0000047	70 to 212°F (20 to 100°C)
Tantalum	0.0000036	70 to 212°F (20 to 100°C)
Zirconium	0.0000031 0.0000024	-300 to 70 °F (-185 to 21 °C) 70 to 600 °F (21 to 315 °C)

†Reference for values of α_{PE} and α_{P} for various orifice and pipe materials.
R. W. Miller, *Flow Measurement Engineering Handbook*, Second Edition, McGraw-Hill Publishing Company

Coefficient of Thermal Expansion for Materials

$$\alpha_P = a T_f^3 + b T_f^2 + c T_f + \text{constant} \qquad \text{Eqn. (C-75a)}$$

(Linear Regressions of ASME MFC 3M Data)

-325 °F ≤ T ≤ 70 °F (-198.3°C ≤ T ≤ 21.1°C)
70 °F < T ≤ 1400 °F (21.1 °C < T < 760 °C)

$$\alpha_P = a T_f^6 + b T_f^5 + c T_f^4 + d T_f^3 + e T_f^2 + f T_f + \text{constant} \qquad \text{Eqn. (C-75b)}$$

Note: Refer to Table C2 below for values of a, b, c... constants. Units for T_f are Farenheit.

Table C2 - Coefficient of Thermal Expansion for Materials ††

Material	Temp Range - T_f	CONTANTS	
		constant	VALUE
Carbon Steels & < 5% Chrome-Moly Steels	-325 °F ≤ T_f ≤ 70 °F (-198.3°C ≤ T_f ≤ 21.1°C)	a	-9.945750e-09
		b	-4.702038e-06
		c	2.382829e-03
		constant	5.929653e+00
	70 °F < T_f ≤ 1400 °F (21.1 °C < T_f < 760 °C)	a	1.153206e-18
		b	-3.137156e-15
		c	1.440833e-12
		d	1.983241e-09
		e	-2.211883e-06
		f	2.879414e-03
		constant	5.877844e+00
Chrome-Moly Steels	-325 °F ≤ T_f ≤ 70 °F (-198.3°C ≤ T ≤ 21.1°C)	a	1.369938e-09
		b	-5.794838e-07
		c	2.339580e-03
		constant	5.568599e+00
	70 °F < T_f ≤ 1400 °F (21.1 °C < T_f < 760 °C)	a	-2.518909e-18
		b	1.300402e-14
		c	-2.625178e-11
		d	2.573783e-08
		e	-1.277971e-05
		f	4.559891e-03
		constant	5.466141e+00
Austenitic 300+ Stainless Steels	-325 °F ≤ T_f ≤ 70 °F (-198.3°C ≤ T_f ≤ 21.1°C)	a	-1.832977e-08
		b	-8.064688e-06
		c	1.982780e-03
		constant	9.017009e+00
	70 °F < T_f ≤ 1400 °F (21.1 °C < T_f < 760 °C)	a	1.132526e-18
		b	-4.221258e-15
		c	4.699460e-12
		d	-5.219868e-10
		e	-2.030544e-06
		f	2.264937e-03
		constant	8.962296e+00

Material	Temp Range - T_f	CONTANTS	
		constant	VALUE
Straight Chromium 400+ Stainless Steels	-325 °F $\leq T_f \leq$ 70 °F (-198.3°C $\leq T_f \leq$ 21.1°C)	a	-1.808318e-08
		b	-6.896268e-06
		c	2.208450e-03
		constant	5.125403e+00
	70 °F < $T_f \leq$ 1400 °F (21.1 °C < T_f < 760 °C)	a	-8.609866e-19
		b	4.927743e-15
		c	-1.070291e-11
		d	1.087353e-08
		e	-5.647216e-06
		f	2.980063e-03
		constant	5.056191e+00
Carpenter 20	-200 °F < $T_f \leq$ 1400 °F (-129 °C < T_f < 760 °C)	a	8.344740e-19
		b	-9.873898e-16
		c	-2.709424e-12
		d	4.300834e-09
		e	-1.214376e-6
		f	1..088461e-03
		constant	8.147090e+00
Inconel 600	-200 °F < $T_f \leq$ 1400 °F (-129 °C < T_f < 760 °C)	a	-9.027777e-17
		b	2.453525e-13
		c	-2.657585e-10
		d	1.482029e-07
		e	-4.672587e-05
		f	9.920853e-03
		constant	6.251250e+00
Inconel 625	-200 °F < $T_f \leq$ 1400 °F (-129 °C < T_f < 760 °C)	a	-5.310521e-18
		b	2.106845e-14
		c	-3.220023e-11
		d	2.510267e-08
		e	-1.103761e-05
		f	3.557491e-03
		constant	6.634752e+00
Inconel 800	100 °F < $T_f \leq$ 1000 °F (38 °C < T_f < 538 °C)	a	-6.944445e-19
		b	1.907051e-15
		c	-5.013355e-12
		d	1.063687e-08
		e	-1.147270e-05
		f	6.645999e-03
		constant	7.390333e+00
Nickel 200	-200 °F < $T_f \leq$ 1400 °F (-129 °C < T_f < 760 °C)	a	1.233529e-18
		b	-7.275935e-15
		c	1.496552e-11
		d	-1.286410e-08
		e	2.982077e-06
		f	2.935833e-03
		constant	6.566590e+00

††Quadratic equations determined by linear regression of polynomial expression for data found in: ASME MFC-3M-1989, "Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi," Table E1, pages 58 and 59.

$$F_L = \frac{g}{32.17405} \qquad \textbf{Eqn. (C-76)}$$

$$x = \frac{\text{mass of gas}}{\text{mass of mixture}} \times 100 \qquad \text{Eqn. (C-81)}$$

Manometer Factor

Correction for Local Gravity

Manometer Correction Factor

$$F_m = (1 \quad D_{fl}/D_m)F_L \qquad \text{Eqn. (C-77)}$$

Drain/Vent Hole Correction Factor (Square-edged Hole)

For Orifice Plates

$$F_{DH} = 1 + \sqrt{1 - \beta^4}\left(\frac{d_{DH}}{d}\right)^2 \qquad \text{Eqn. (C-78)}$$

For Nozzles and Venturi

$$F_{DH} = 1 + 0.6\sqrt{1 - \beta^4}\left(\frac{d_{DH}}{d}\right)^2 \qquad \text{Eqn. (C-79)}$$

Water Vapor Factor

$$F_{WV,dry} = 1 - P_{WV}/P_{fl} \qquad \text{Eqn. (C-80)}$$

Saturated Liquid Factor

Mixture Quality, x

Calculation for Two-Phase Density, D_{TP}

$$D_{TP} = \frac{D_{LIQUID}}{1 + (x/100)(D_{GAS}/D_{LIQUID} - 1)} \qquad \text{Eqn. (C-82)}$$

For Quality, x = 0;

$$F_x = 0.968 + 0.112\,beta F_x = 0.968 + 0.112\,\beta \qquad \text{Eqn. (C-83)}$$

For Quality, 10% $\geq$ x > 0

$$F_x = 0.94 + 0.2\,(D_{LIQUID}/D_{TP}) - 0.01\,(D_{LIQUID}/D_{TP})^2 \qquad \text{Eqn. (C-84)}$$

Quality Factor

$$D_{TP} = \frac{1}{x + 1.26\,(1 - x)\,(D_{GAS}/D_{TP})^{1/2}} \qquad \text{Eqn. (C-85)}$$

Permanent Pressure Loss Equations

Orifice Plate

$$dP\ LOSS\ \% = \frac{\sqrt{1 - \beta^4} - C\,\beta^2}{\sqrt{1 - \beta^4} + C\,\beta^2} \qquad \text{Eqn. (C-86)}$$

Nozzle

$$dP\ LOSS\ \% = 1 - 0.014\,\beta - 2.06\,\beta^2 + 1.18\,\beta^3 \qquad \text{Eqn. (C-87)}$$

Venturi

15° exit cone

$$dP\ LOSS\ \% = 0.436 - 0.86\,\beta + 0.59\,\beta^2 \qquad \text{Eqn. (C-88)}$$

7° exit cone

$$dP\ LOSS\ \% = 0.218 - 0.42\,\beta + 0.38\,\beta^2 \qquad \text{Eqn. (C-89)}$$

Lo-Loss Tube

$$dP\ LOSS\ \% = 0.151 - 0.304\,\beta + 0.182\,\beta^2 \qquad \text{Eqn. (C-90)}$$

Universal Venturi Tube

$$dP\ LOSS\ \% = 0.065 - 0.092\,\beta + 0.167\,\beta^2 \qquad \text{Eqn. (C-91)}$$

Critical Flow Equations

Gases and Vapors

Critical Flow Function, Y_{CR}

$$Y_{CR} = \left[\frac{k}{Z_{f1}} \left(\frac{2}{k+1} \right)^{(k+1)/(k-1)} \right]^{1/2} \qquad \text{Eqn. (C-92)}$$

Choked Downstream Pressure

$$P_{choked} = P_{f1} F_{TP} \left(\frac{2}{k+1} \right)^{k/(k-1)} \qquad \text{Eqn. (C-93)}$$

Static Pressure to Total Pressure Factor, F_{TP}

$$F_{TP} = \left[1 + \beta^4 \frac{k}{2} \left(\frac{2}{k+1} \right)^{(k+1)/(k-1)} \right] \qquad \text{Eqn. (C-94)}$$

Gas and Vapor Flow Rate Equations for Critical Flow Meters

Gases - Volumetric Flow Rate at Base Conditions - PVT Equation

$$Q = 813.5358\, C\, d^2 \frac{Z_b T_b}{P_b} Y_{CR} \sqrt{\frac{1}{T_{f1} G}} F_{TP} P_{f1} \qquad \text{Eqn. (C-95)}$$

Gases - Volumetric Flow Rate at Base Conditions - Density Equation

$$Q = 1336.485\, C\, d^2 \sqrt{Z_{f1}}\, Y_{CR} \frac{\sqrt{D_{f1}}}{D_b} \sqrt{F_{TP} P_{f1}} \qquad \text{Eqn (C-96)}$$

Gases - Volumetric Flow Rate at Flow Conditions - PVT Equation

$$q = 813.5358\, C\, d^2 Z_{f1}\, Y_{CR} \sqrt{\frac{T_{f1}}{G}} \qquad \text{Eqn. (C-97)}$$

Gases - Volumetric Flow Rate at Flow Conditions - Density Equation

$$q = 1336.485\, C\, d^2 \sqrt{Z_{f1}}\, Y_{CR} \sqrt{\frac{F_{TP} P_{f1}}{D_{f1}}} \qquad \text{Eqn. (C-98)}$$

Vapors - Mass Flow Rate at Flow Conditions - PVT Equation

$$W = 2195.591\, C\, d^2 Y_{CR} \sqrt{\frac{G}{T_{f1}}} F_{TP} P_{f1} \qquad \text{Eqn. (C-99)}$$

Vapors - Mass Flow Rate at Flow Conditions - Density Equation

$$W = 1336.485\, C\, d^2 \sqrt{Z_{f1}}\, Y_{CR} \sqrt{D_{f1} F_{TP} P_{f1}} \qquad \text{Eqn. (C-100)}$$

Discharge Coefficient Equation for Gas/Vapor Critical Flow Meters

$$C = a - b / R_d^n \qquad \text{Eqn. (C-101)}$$

Table C3 Discharge-Coefficient-Equation Constants for Critical Flow Meters

Critical Flow Device	Constants		
	a	b	n
ISO toroidal throat (< 0.25) $10^5 < R_d < 10^7$	0.99354	1.525	0.5
ISO cylindrical throat and ASME long-radius nozzle (b < 0.25) $10^4 < R_d < 4 \times 10^5$ $4 \times 10^5 < R_d < 2.8 \times 10^6$ $2.8 \times 10^6 < R_d < 2 \times 10^7$	 1.0000 0.9886 1.000	 7.21 0 0.222	 0.5 0 0.2
Square-edged orifice (b < 0.5 and plate thickness, d to 6d) $R_d > 10^5$	0.83932	0	0

Liquids

The liquid sizing equations of Equations D-7 through D-12 for liquid meters may be used after converting the equations to solving for flow and substituting the following equation for the meter differential, dP.

$$dP = 27.72976 (P_{fl} - P_v) \qquad \textbf{Eqn. (C-102)}$$

Symbols, Nomenclature, and Associated Units

Symbol	Description	Units
C	Discharge coefficient, true flow rate divided by the theoretical flow rate.	Dimensionless
C_∞	Discharge coefficient at an infinite Reynolds number.	Dimensionless
d	Bore of head-type flow meter measured at actual flowing temperature.	inches
$d_{(ref)}$	Bore of head-type flow meter measured at 68°F (20°C).	inches
d_{DH}	Diameter of a drain or vent hole.	inches
dP	Differential pressure across the meter.	inches of water column
dP_m	Differential pressure across the meter measured at maximum flow.	inches of water column
dP_n	Differential pressure across the meter measured at normal flow.	inches of water column
D	Internal pipe diameter measured at actual flowing temperature.	inches
$D_{(ref)}$	Internal pipe diameter measured at 68°F (20°C).	inches
D_b	Density at base conditions:	lb / ft^3
D_c	Diameter of circle containing the segment of a segmental orifice.	inches
D_f	Density of a liquid at flowing temperature.	lb / ft^3
D_{f1}	Density of a gas or vapor at upstream-tap flowing conditions.	lb / ft^3
D_{f2}	Density of a gas or vapor at downstream-tap flowing conditions.	lb / ft^3
D_F	Density of liquid at flowing conditions, uncorrected for pressure.	lb / ft^3
D_{GAS}	Density of gas or vapor portion of a two-phase liquid/vapor fluid.	lb / ft^3
D_{LIQUID}	Density of liquid portion of a two-phase vapor/liquid fluid.	lb / ft^3
D_M	Manometer-fluid density.	lb / ft^3
D_{TP}	Effective or homogeneous density of a two-phase fluid.	lb / ft^3
E	Velocity-of-approach factor for Buckingham Flow Coefficient Correlation.	Dimensionless
F_{aD}	Thermal expansion factor for the pipe.	Dimensionless
F_{ad}	Thermal expansion factor for the flow meter.	Dimensionless
F_{DH}	Drain (gases or vapors) or vent (liquids) hole correction factor.	Dimensionless
F_L	Local gravity correction factor.	lb_f / lb_m
F_m	Manometer correction factor.	Dimensionless
F_p	Correction for liquid compressibility, D_f / D_F (usually 1.0 except at very high pressures).	Dimensionless
F_{SAT}	Correction for saturated liquid (two-phase flow) conditions.	Dimensionless

Symbol	Description	Units
F_{TP}	Factor correcting static pressure to total pressure for critical drop sizing of gases and vapors.	Dimensionless
$F_{WV,dry}$	Correction for wet-gas volume or mass to dry-gas volume or mass.	Dimensionless
F_X	Wet-steam or wet-vapor quality correction factor.	Dimensionless
G_b	Liquid base specific gravity with respect to water at 60°F.	Dimensionless
G_f	Liquid flowing specific gravity at flowing temperature.	Dimensionless
H_S	Segmental orifice plate height.	inches
k	Ideal gas isentropic exponent or specific heat ratio (Cp/Cv).	Dimensionless
K	Flow coefficient, $K = C / (1 - \ ^4)^{½}$.	Dimensionless
K_0	Flow coefficient including velocity of approach at a hypothetical Reynolds number of infinity.	Dimensionless
L_1	Is the quotient of the distance of the upstream tapping from the upstream face of the plate and the plate diameter	inches
L_2	Is the quotient of the distance of the downstream tapping from the downstream face of the plate and the plate diameter	inches
M_W	Molecular weight.	$lb_m / lb_m \cdot mol$
P_b	Base absolute pressure for gas volume flows.	psia
P_{f1}	Absolute static pressure at upstream-tap flowing conditions.	psia
P_{f2}	Absolute static pressure at downstream-tap flowing conditions.	psia
P_{WV}	Absolute pressure of water vapor in gas-water vapor mixture.	psia
P_v	Vapor pressure of liquid at flowing temperature.	psia
q	Gas or liquid volumetric flow rate at actual (flowing) conditions.	ft^3 / hr (gas) gpm (liquid)
q_m	Gas or liquid maximum volumetric flow rate at actual (flowing) conditions.	ft^3 / hr (gas) gpm (liquid)
q_n	Gas or liquid normal volumetric flow rate at actual (flowing) conditions.	ft^3 / hr (gas) gpm (liquid)
Q	Gas or liquid volumetric flow rate at base conditions.	scfh (gas)
Q_m	Gas or liquid maximum volumetric flow rate at base conditions.	scfh (gas) USBL/D (liquid)
Q_n	Gas or liquid normal volumetric flow rate at base conditions.	scfh (gas) USBL/D (liquid)
R_d	Reynolds number of the meter bore.	Dimensionless
R_D	Reynolds number calculated with respect to D (inner diameter of pipe).	Dimensionless
Re(D)	Reynolds number calculated with respect to D (inner diameter of pipe).	Dimensionless
T_b	Base absolute temperature for gas volume flows.	°R

T_{f1}	Temperature of gas, vapor or liquid at upstream-tap flowing conditions.	°R
T_{f2}	Temperature of gas, vapor or liquid at downstream-tap flowing conditions.	°R
T_F	Temperature at flowing conditions in degrees Fahrenheit.	°F
U	Absolute viscosity of gas, vapor or liquid.	cP
x	Quality or mass percent of vapor mass portion to total mass portion of a two-phase fluid.	Dimensionless
X_1	Pressure ratio at the upstream tap pressure of the orifice, dP/P_{f1}.	Dimensionless
X_2	Pressure ratio at the downstream tap pressure of the orifice, dP/P_{f2}.	Dimensionless
W	Vapor or liquid mass flow rate.	lb / hr
W_m	Vapor or liquid maximum mass flow rate.	lb / hr
W_n	Vapor or liquid normal mass flow rate.	lb / hr
Y	Gas expansion factor.	Dimensionless
Y_{CR}	Critical flow function.	Dimensionless
Y_1	Gas expansion factor at the upstream tap pressure of the orifice.	Dimensionless
Y_2	Gas expansion factor at the downstream tap pressure of the orifice.	Dimensionless
Z_b	Gas or vapor compressibility factor at base temperature and pressure.	Dimensionless
Z_{f1}	Gas or vapor compressibility factor at upstream-tap flowing conditions.	Dimensionless
Z_{f2}	Gas or vapor compressibility factor at downstream-tap flowing conditions.	Dimensionless
α_P	Thermal-expansion coefficient for pipe material.	in. / (in.-°F)
α_{PE}	Thermal-expansion coefficient for primary-element material.	in. / (in.-°F)
β	Beta ratio, d/D.	Dimensionless
β_C	Segment beta ratio for a segmental orifice, /0.98.	Dimensionless
β_{wedge}	Equivalent beta ratio for a wedge style meter.	Dimensionless

INDEX

About. 52
ASCII delimited text file. 65
ASME Long Radius. 43
ASME Steam Tables (1967 IPC Formulation for Industrial Use). 85
ASME Throat Tap. 43
Base Condition Data.. 55
Base menu. 23
Base.... . . . . 15, 48
    Base Pressure. 48
    Base Temperature. 48
    Pressure Tap Location.. 48
Batch Print. 29
Batch Print Index Options. 29
Benedict-Rubin-Webb. 85
Calc Fluid Properties. 58
Calculate.. 59
    calculate the sizing parameter. 59
Calculate command. 33
Calculation. 27
    Batch Calc.. 27
    Clear Calc. 27
Calculation Modes. 36
    Critical Drop Restriction Sizing. 36
    Flow Meter Sizing.. 36
    Restrictive Pressure Drop Sizing.. 36
Calculation Screen. 59
Calculation Setup. 35, 56
Clear Mix. 86
Company Data. 53
Company Data.... 49
Component Buttons 1 thru 20.. 86
Components Select List. 85
Concentric Bore. 42
Confirm Project File Delete. 26
Conic-edged. 42
Critical Drop - Nozzle.... 46
    ASME Long Radius/ISO Cylindrical Nozzle. 46
    ISO Toroidal Nozzle.. 46
Critical Drop - Orifice Plate.... 46
    Square-edged orifice plate.. 46
    Thick orifice plate.. 46
Custom Meter.... 46
    Flow Nozzle. 47
    Flow Tube.. 47
    Orifice Plate. 47
    Venturi. 47
Customer Data. 53
Customer Data.... 49

Data Sheet. 27
Clear Data Sheet. 27
Data Sheet Entry - Part 1 of 3. 61
Data Sheet Entry - Part 2 of 3. 62
Data Sheet Entry - Part 3 of 3. 63
Element. 62
Enter Data sheet Data.... 27
Fluid. 61
Header. 61
Meter Data. 63
Notes. 63
Options. 63
Pipe. 62
Service. 61
Taps. 62
Delete Tag. 32
dialog box. 17
Drain/Vent Hole Factor (F_{DH}). 37
drop-down list box. 17
drop-down list boxes. 17
Eccentric Bore. 42
edit boxes. 17
ellipsis (...). 17
Equation-of-State. 85
Equations-of-State. 87
ASME Steam Tables (1967 IPC Formulation for Industrial Use). 85
Benedict-Webb-Rubin. 88
Redlich Kwong. 87
Soave-Redlich Kwong. 87
Exit. 31
Factors. 15, 36, 59
Drain/Vent Hole Factor (F_{DH}). 37
Manometer Factor (F_M). 36
Saturated Liquid Factor (F_{SAT}). 40
Vapor Quality Factor (F_X). 40
Water Vapor Correction Factor (F_{WV}). 38
File. 14, 30
Calculation. 14, 27
Data sheet. 14, 27
Exit. 14, 31
Most Recent Files. 31
Most Recent Files List. 14
Print. 14, 27
Print Preview. 14
Print Preview 29
Print Setup.... 14
Project. 14
Utilities. 14, 30
filename. 24
Flow Nozzle.... 43
flowing conditions. 34, 35

Fluid. 15
Calculate Fluid Properties.... 15
Gas - Volume.... 15
Input Fluid Data. 15
Liquid - Mass.... 15
fluid property correlations. 85
Benedict-Rubin-Webb.. 85
Hankinson-Brobst-Thomson (HBT). 85
Redlich-Kwong. 85
Soave-Redlich-Kwong. 85
Fluids. 32, 58
Calc Fluid Properties.. . . . . 33, 58
Gas-Volume. 33
Input Fluid Data. 33, 58
Liquid-Volume. 34
Gas-Volume. 33
Get Mix. 86
Hankinson-Brobst-Thomson (HBT).. 85
Help. 16, 52
About.. . . . . 16, 52
Index. 16, 52
Using Help. 52
Using Help 16
Honed Meter Run. 42
Import Project File. 26
import/export function. 65
Input Fluid Data. 58
Input Sizing Data. 35, 57
Input Tag Data. 31
Line No.. 32
Service Description. 32
Tag No.. 31
insertion point.. 17
Integral Orifice. 42
ISA Nozzle. 43
Line No.. 57
Liquid-Volume. 34
Lo Loss Flow Tube.... 45
Manometer Factor (F_M). 36
menu bar. 13, 23
Base.... 13
Factor. 13
File. 13
Fluids.. 13
Help.. 14
Meter/Pipe.. 13
Sizing. 13
Tag. 13
Utility. 14
View. 14
Window.. 14

Meter Data. 41, 57
Critical Drop - Nozzle.... 46
Critical Drop - Orifice Plate.... 46
Custom Meter..... 46
Flow Nozzle.... 43
Lo Loss Flow Tube.... 45
Orifice Plate. 42
Universal Venturi Tube.... 45
Venturi Data.... 44
Wedge Meter Selection.... 45
Meter/Pipe. 15, 41
Meter Data. 41
Meter Type. 15
Pipe Data.... 15
Meter/Pipe Data. 10, 11
Most Recent Files.. 31
New Project. 24
Orifice Plate.... 42
Pipe Data. 47, 58
Pipe Inner Diameter. 48
Pipe Material Selection. 48
Pipe Nominal Diameter. 47
Pipe Schedule. 47
Plate Material Selection. 17
pop-up menu. 16
Print. 27
Batch Print - Calc Sheets. 28
Batch Print - Data Sheets. 29
Batch Print - Tag Index. 29
Calc Sheet. 27
Calibration Chart. 28
Data Sheet. 28
Meter Uncertainty Calc. 28
Print Preview 29
Print Setup. 30
Project. 24
Close Project. 25
Delete Project. 26
Export ASCII File. 26
Import ASCII File. 26
New Project. 24
Open Project. 25
Save Project. 25
project database. 53
pull-down menu. 23
Quadrant-edged. 42
Redlich-Kwong. 85
Relative Humidity. 39
Retrieve Tag. 32
Saturated Liquid Factor (F_{SAT}). 40
Save Mix. 86
Save Project. 56

Save Tag.. 32
Segmental Bore. 42
Service Description. 57
Single Component & Multi-Component Fluid Selection. 85
Sizing. 15, 35
    Calculation Setup. 35
    Calculation Setup.... 15
    Input Sizing Data.. . . . . 15, 35
Sizing Data. 58
    Sizing Data. 10
    sizing parameter. 10
sizing parameter. 10, 15, 56
    Calculate for Bore. 56
    Calculate for Flow. 56
    Calulate for dP. 56
sizing screen. 13, 23
Soave-Redlich-Kwong. 85
status bar. 21
Symbols and Nomenclature. 23
Tag. 14, 31
    Delete Tag.. 32
    Delete Tag.... 14
    Input Tag Data. 14, 31
    Retrieve Tag. 32
    Retrieve Tag.... 14
    Save Tag. 32
    Save Tag..... 14
Tag Index. 29
Tag No.. 57
text boxes. 17
Uncertainty Calculation Setup. 54
Uncertainty.... 50
Universal Venturi Tube.... 45
User Data
    Company Data.... 49
    Customer Data.... 49
Utilities.. 30
    Pack Project Database.. 30
    Rebuild Project Index. 30
Utility. 15, 49
    Uncertainty..... . . . . 15, 50
    Units.... . . . . 15, 49
    User Data. 15, 49
Vapor Quality Factor (F_X). 40
Venturi Data.... 44
Venturi Exit
    15 Degree Exit Cone. 44
    7 Degree Exit Cone. 44
Venturi Nozzle - (ISA Inlet).. 43

Venturi Type. 44, 45
Machined inlet. 44, 45
Rough-cast inlet. 44
Rough-welded sheet-iron inlet. 44
View. 16, 52
Status Bar. 16, 52
Tool Bar. 16, 52
volume conditions. 34
Water Vapor Correction Factor (F_{WV}). 38
Wedge Meter Selection. 45
ABB proprietary Wedge Meter. 45
Generic Wedge Meter. 45
Window. 16, 51
Arrange Icons. 16, 52
Cascade. 16, 51
Tile. 16, 52
Window 1, 2, ... 52

Control-Soft Enterprises

FE-Sizer - Flow Meter Sizing
Windows Version 3.0
© 1994-2010 Control-Soft Enterprises
All Rights Reserved.
Printed in U.S.A.

Control-Soft Enterprises • 2319 Morning Park Drive • Katy, Texas 77494-2111
U.S.A.